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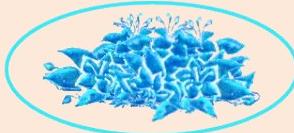
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Contacts:

Professor Dr.Ahmad Sanusi Hassan (Editor-in-Chief), School of Housing, Building and Planning, UNIVERSITI SAINS MALAYSIA, 11800 Minden, Penang, MALAYSIA. Tel: +60-4-653-2835 Fax: +60-4-657 6523, Sanusi @ usm.my, Editor @ TuEngr.com

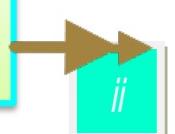
Associate Professor Dr.Boonsap Witchayangkoon (Executive Editor), Thammasat School of Engineering, THAMMASAT UNIVERSITY, Klong-Luang, Pathumtani, 12120, THAILAND. Tel: +66-2-5643005 Ext 3101. Fax: +66-2-5643022 DrBoonsap @ gmail.com, Editor @ TuEngr.com

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TUENGR Group, 88/244 Moo 3, Moo Baan Saransiri, Klong#2, KlongLuang, Pathumtani, 12120, THAILAND. Tel/WhatsApp: +66-995535450.

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Hedonic Price Model of Secondhand Condominium Units in Bangkok

Kongkoon Tochaiwat^{1*}, Phonthanat Uruhamanon¹,
Patcharida Pultawee¹, Sittichai Naksuksakul²

¹ Faculty of Architecture and Planning, Thammasat University, THAILAND.

² PTT Public Company (Limited), THAILAND.

*Corresponding Author (Tel: +66-992893328, kongkoon@gmail.com)

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Abstract

In this research, the objective was to explore prices of secondhand condominium units in Bangkok, as well as to generate a hedonic price model. The data from 200 samples of secondhand condominiums posted on six well-known secondhand real estate websites in Thailand were gathered and analyzed by Multiple Regression Analysis. A hedonic price model with a logarithmic form with an adjusted R² of 72.7 percent was proposed. There are a total of 11 determinants regarding customer satisfaction, in which six variables have negative effects while the remaining determinants have positive effects. From the paired sample t-test, the means of the observed selling prices and the predicted selling prices are not significantly different, at a 95 percent confidence level.

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1 Introduction

In 2010, the number of condominiums in Bangkok presented at 34,381 units, but as the high growth of condominium supplies, there were about 566,583 units in the first half of 2019. At the same time, the demands decreased which directly affected the sale rate because of the weak economy, loan-to-value limitation measure, and strong Thai baht against the U.S. dollar and Chinese Yuan. Therefore, this totally changed the estate developers' action plans as they

postponed their condominium projects to clear their stocks, and launched other projects, such as single-detached houses, semi-detached houses, and townhouses instead (Knight Frank, 2019).

Various factors encourage buyers' preference to buy secondhand condominiums rather than buying a new condominium. The first factor is the price because the price of a secondhand condominium is cheaper than the price of a new condominium even if the projects are close by (Pitchon, 2019). On the other hand, secondhand condominiums would normally be offered at the more usable areas than new ones at the same price. Because everyone desires to live in a good location and nearby facilities, i.e. business area, land or underground mass transit station, suitable price, and location are the factors of decision making. For the investors, buying a secondhand condominium at a low price and a good location could bring them greater returns (Frank, 2019).

The hedonic price model could help buyers find the most suitable price, reduce risk, and increase profitability (Virsnieks, 2001; Ross, 2008; Rosen, 1974; Rinchumphu, Kridakorn Na Ayutthaya & Yunus, 2020; Khumpaisal, Weeraprajack & Dechphun, 2016). In this research, the acquired hedonic price model will answer what are the determinants of the selling prices of secondhand condominiums and will predict the selling prices of the secondhand condominiums in Bangkok.

2 Review of Literature

Typically, the price of a condominium depends on many factors, as shown in Table 1. It mainly relies on the location, i.e. mass transit station, main road, convenience, and shopping mall. Other determinants consist of floor level, age of condominium, room size, and area location.

Table 1: Determinants of Secondhand Condominium Unit Price.

No.	Determinant	Mok et al. (1995)	Choy, et al. (2007)	Banthaokul (2007)	Kulkolkarn & Laophairoj (2012)	Chutamat (2015)	Kulkosa (2017)	Wipoomitsaksul (2019)	Suwanphorung (2018)	Sawadmoor (2018)
1.	Project Developers				✓	✓		✓	✓	
2.	Age of Condominium Building	✓	✓	✓				✓		✓
3.	Room Unit Size			✓	✓			✓	✓	✓
4.	Area Location of the Condominium				✓	✓	✓		✓	
5.	Types of Building							✓		
6.	Floor Level	✓	✓	✓	✓	✓				✓
7.	Number of Bedrooms				✓	✓			✓	
8.	Number of Bathrooms								✓	
9.	Furnishing				✓	✓				
10.	Electrical Appliances								✓	
11.	Distance to Mass Transit Stations	✓	✓	✓	✓	✓	✓	✓	✓	✓
12.	Distance to Main Roads			✓				✓		
13.	Distance to Convenience Stores								✓	
14.	Distance to Shopping Malls								✓	✓

3 Research Methodology

The research started by studying the related theories and research works regarding the secondhand condominiums in Bangkok and the hedonic price model, then design the research methodology. This is a quantitative study, which all data were collected from the condominium units posted for sale on estate websites from February-April 2020. The required data were recorded by the research checklist and used in analyzing the hedonic price model of condominium units in Bangkok by Multiple Regression Analysis.

Table 2: Determinants of Secondhand Condominium Unit Price.

No.	Determinant	Details	Variable Type	Unit
1	Room size	Room area posted on the websites	Ratio	Square meters
2	Number of bedrooms	The total number of bedrooms posted on the website. The studio room is equal to zero bedrooms.	Ratio	Room
3	Number of bathrooms	Total number of bathrooms posted on the website	Ratio	Room
4	Floor level	The floor number that the unit located	Ratio	Level
5	The unit is fully furnished	1 if the unit is a fully furnished room, 0 if not	Dummy	No unit
6	The unit is fully fitted	1 if the unit is fully fitted room, 0 if not	Dummy	No unit
7	The room has air conditioner.	1 if the unit has an air conditioner, 0 if not	Dummy	No unit
8	The room has refrigerator.	1 if the unit has a refrigerator, 0 if not	Dummy	No unit
9	The room has washing machine.	1 if the unit has a washing machine, 0 if not	Dummy	No unit
10	The room has water heater.	1 if the unit has a water heater, 0 if not	Dummy	No unit
11	The room has microwave.	1 if the unit has a microwave, 0 if not	Dummy	No unit
12	The room has cooker hob and hood.	1 if the unit has cooker hob and hood, 0 if not	Dummy	No unit
13	The room has dishwasher.	1 if the unit has a dishwasher, 0 if not	Dummy	No unit
14	Age of building	Age counted from the completed construction year until the year 2020	Ratio	Years
15	High-rise building	1 if the unit is in a high-rise building (more than 8 stories), 0 if not	Dummy	No unit
16	Developed by the listed company	1 if the unit was developed by the listed company in the Stock Exchange of Thailand, 0 if not	Dummy	No unit
17	Percentage of parking lot	The ratio of parking lots and the number of units in a condominium	Ratio	Percent
18	The condominium has lift.	1 if the condominium has a lift, 0 if not	Dummy	No unit
19	The condominium has fitness room	1 if the condominium has a fitness room, 0 if not	Dummy	No unit
20	The condominium has swimming pool	1 if the condominium has a swimming pool, 0 if not	Dummy	No unit
21	The condominium has sauna room	1 if the condominium has a sauna room, 0 if not	Dummy	No unit
22	The condominium has wi-fi	1 if the condominium has Wi-Fi, 0 if not	Dummy	No unit
23	The condominium has playground	1 if the condominium has a playground, 0 if not	Dummy	No unit
24	The condominium has cctv	1 if the condominium has CCTV, 0 if not	Dummy	No unit
25	The condominium has 24 hours security guard	1 if the condominium has 24 hours security guard, 0 if not	Dummy	No unit
26	The condominium has key card access.	1 if the condominium has key card access, 0 if not	Dummy	No unit
27	The condominium has lift-access control.	1 if the condominium has lift-access control, 0 if not	Dummy	No unit
28	The unit has digital door lock	1 if the unit has a digital door lock, 0 if not	Dummy	No unit
29	The condominium is located in Inner Bangkok.	1 if the condominium is located in Inner Bangkok, 0 if not	Dummy	No unit
30	The condominium is located in middle Bangkok.	1 if the condominium is located in the Middle Bangkok, 0 if not	Dummy	No unit
31	Distance to mass transit station	Distance from condominium to the nearest mass transit station	Ratio	Kilometers
32	Distance to main road	Distance from condominium to the nearest main road	Ratio	Kilometers
33	Distance to convenience stores	Distance from condominium to the nearest convenience store	Ratio	Kilometers
34	Distance to shopping malls	Distance from condominium to the nearest shopping mall	Ratio	Kilometers

The researchers define the model variables from related literature as shown in Table 1 and the real estate websites. The acquired variables consisted of 34 determinants (independent variables) and 1 dependent variable. The dependent variable of this research was the “selling price” of the secondhand condominium unit posted on estate websites, in baht per square meter. The acquired 34 determinants of the price of a secondhand condominium unit are shown in Table 2.

The samples used in this research were 200 secondhand condominium units, with the selling prices below 200,000 baht per square meter, posted on 5 estate websites, as mentioned above, with the suggestion that the sample size must not be less than 5 samples per determinant proposed by Bartlett, Kotrlik, & Higgins (2011). It should be noted that the data were collected from 3 zones of Bangkok: 21 districts of inner Bangkok, 18 districts of middle Bangkok, and 18 districts of outer Bangkok.

Then, the researchers analyzed the data by a statistical computer program to find the sample correlation coefficient and statistical results of Multiple Regression Analysis. There were three groups of attributes included in the checklist: (1) the attributes of secondhand condominium units directly appeared in real estate websites: selling price, room size, number of bedrooms and bathrooms, floor-to-floor level, furnishing, and electrical appliances included; (2) the attributes of condominium buildings - Some websites, e.g. homenayoo.com and thinkofliving.com, contained the data of the condominium buildings; and, (3) the data of distance from the condominium buildings to interested facilities or infrastructures such as mass transit stations, shopping malls, and main roads – The distance can be measured from a navigation website.

The data analysis of this research consists of 3 techniques: (1) Item-Objective Congruence Index (IOC) was applied for determinant screening, where the determinants with IOC equal or greater than 0.50 shall be put into the prediction model; (2) Sample Correlation Coefficient shows the measurement between two linear variables. The equation is defined as follows:

The coefficient ranges from -1 to +1. If the value closes to -1, it indicates a strong negative relationship between two linear variables and vice versa. Finally, (3) Multiple Regression Analysis - A data analysis technique that has an assumption that the dependent variable (Y) is a function of independent variables (X_1, X_2, \dots, X_p) and an error term or a random variable (ε). The coefficient $\beta_0, \beta_1, \beta_2, \dots, \beta_p$ are the regression parameters. The multiple regression model is as the following equation (Anderson et al., 2001).

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_p X_p + \varepsilon \quad (1)$$

The statistics ($b_0, b_1, b_2, \dots, b_p$) are used to estimate the parameter value. So, the Multiple Regression Analysis equation is as follows (Anderson et al., 2001).

$$\hat{y} = b_0 + b_1 x_1 + b_2 x_2 + \dots + b_p x_p \quad (2)$$

Where \hat{y} is the estimated value of the dependent variable

To test the model accuracy, the Paired Sample t-Test resulted in paired observations to find out the difference of means between two sets of data. There will be statistical procedures applied in this section.

4 Results and Discussion

Among four alternatives, the best model was the ln–ln model because of its compliance with all conditions and the highest Adjust R². The details of four alternative models are summarized in Table 3.

Table 3: Statistical Test Results of Alternative Models.

Statistical Test	Linear-Linear Model	Linear-In Model	In-Linear Model	In-In Model
Adjusted R ²	0.689	0.721	0.702	0.727
VIF of all significant independent variables are less than 10	Satisfied	Satisfied	Satisfied	Satisfied
Durbin-Watson	1.448	1.455	1.595	1.532
Residual Analysis				
(1) Residuals are normally distributed	0.016 Not Satisfied	0.200 Satisfied	0.200 Satisfied	0.200 Satisfied
(2) Residuals' mean is equal to zero	0.000 Satisfied	0.000 Satisfied	0.000 Satisfied	0.000 Satisfied
(3)There is no relationship between each residual	1.448 Not Satisfied	1.455 Not Satisfied	1.595 Not Satisfied	1.532 Satisfied
(4) There is no heteroscedasticity problem	Satisfied	Satisfied	Satisfied	Satisfied
Number of independent variables	10	8	10	11

The ln–ln model of selling price of secondhand condominium, shown as the following equation, has the VIF's of all determinants and the scatter plot of the standardized residuals and the predicted values as shown in Table 4 and Figure 1, respectively. It consists of 11 variables, of which 6 variables are dummy variables and 5 variables are ratio variables.

Table 4: Regression Results of ln-In Model

X	Determinant	B	t	Sig.	Statistics VIF
	Constant	11.976	129.744	0.000	-
x_1	The Condominium Is in Inner Bangkok	-0.558	-5.113	0.000	1.416
x_2	The Condominium Is High-rise Building	0.966	2.994	0.003	1.599
x_3	The Unit Has Digital Door lock	-0.131	-2.644	0.009	1.356
x_4	Distance to Mass Transit Stations	-0.062	-3.288	0.001	1.572
x_5	The Unit Has Cooker Hob and Hood	-0.169	-2.946	0.004	1.307
x_6	The Unit has Refrigerator	0.400	3.356	0.001	1.248
x_7	Age of Building	-0.175	-4.797	0.000	1.300
x_8	Distance to Shopping Mall	-0.108	-3.627	0.000	1.380
x_9	Distance to Convenience Stores	0.011	2.258	0.026	1.222
x_{10}	The Unit Is Fully Furnished	0.090	2.550	0.012	1.246
x_{11}	The proportion of the number of Parking Lots to the Number of Units	0.191	2.244	0.027	1.557

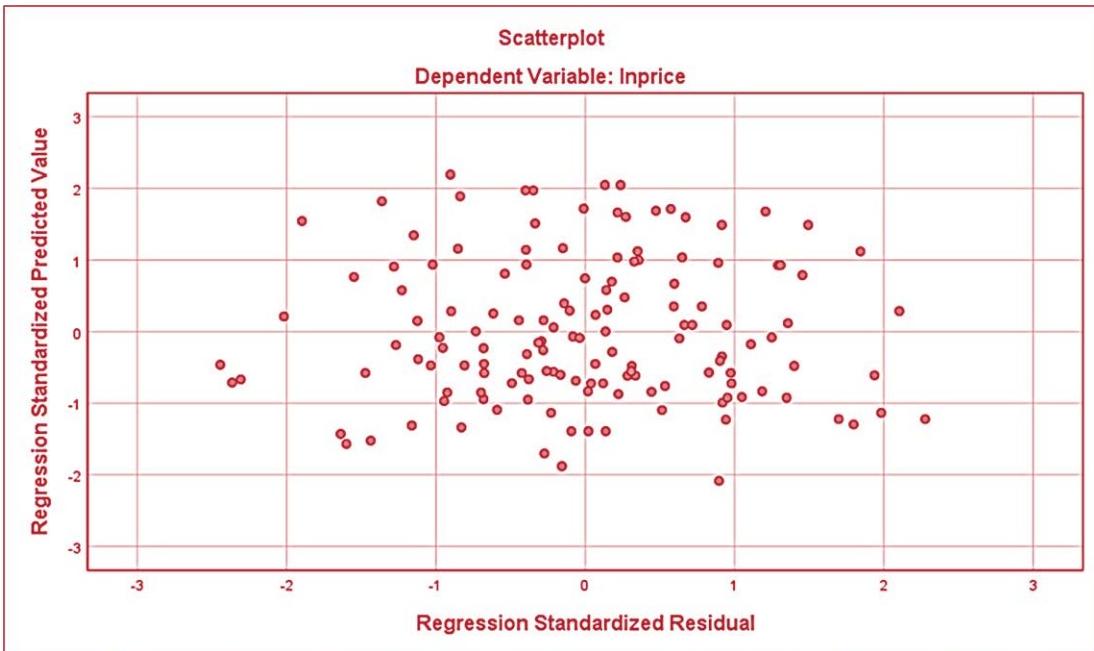


Figure 3 Scatter Plot of Standardized Residuals and Predicted Values of ln-In Model
Hence, the best equation among the alternative equations was as follows:

Therefore, the acquired hedonic price model of the secondhand condominium units in Bangkok is

$$\begin{aligned} \ln y = & 11.976 - 0.558 \ln x_1 + 0.966 \ln x_2 - 0.131 \ln x_3 - 0.062 \ln x_4 \\ & - 0.169 \ln x_5 + 0.400 \ln x_6 - 0.175 \ln x_7 - 0.108 \ln x_8 + 0.011 \ln x_9 \\ & + 0.090 \ln x_{10} + 0.191 \ln x_{11} \end{aligned} \quad (3),$$

where

y = Estimated Selling Price of a Secondhand Condominium Unit

$x_1, x_2, x_3, \dots, x_{11}$ = Determinants of the Selling Price of a Secondhand Condominium Unit, as described in Table 5

Table 5: Determinants of the Proposed Model

X	Determinant	Type of Variable	Unit	Z-score (in case of dummy variable)	
				Yes	No
x_1	The Condominium Is in Inner Bangkok	Dummy	No unit	1.220	-0.814
x_2	The Condominium Is High-rise Building	Dummy	No unit	0.928	-1.070
x_3	The Unit Has Digital Door Lock	Dummy	No unit	1.604	-0.619
x_4	Distance to Mass Transit Station	Ratio	Kilometers	N/A	N/A
x_5	The Unit Has Cooker Hob and Hood	Dummy	No unit	1.472	-0.675
x_6	The Unit Has Refrigerator	Dummy	No unit	0.838	-1.185
x_7	Age of the Building	Ratio	Years	N/A	N/A
x_8	Distance to Shopping Mall	Ratio	Kilometers	N/A	N/A
x_9	Distance to Convenience Store	Ratio	Kilometers	N/A	N/A
x_{10}	The Unit Is Fully Furnished	Dummy	No unit	0.476	-2.086
x_{11}	The proportion of the Number of Parking Lots to the Number of Units	Ratio	Percent	N/A	N/A

A paired sample t-test was applied to test the accuracy of the proposed model. The test hypotheses can be written as follows.

H_0 : The mean of observed prices and the mean of predicted prices are not different.

H_1 : The mean of observed prices and the mean of predicted prices are different.

Table 6 shows the results of a 2-tailed Paired Sample t-Test. As the p-value is greater than 0.05, the null hypothesis (H_0) is not rejected. Hence, the mean of observed prices and the mean of predicted prices are not significantly different and the model has acceptable accuracy.

Table 6: Results of Paired Sample t-Test of In-In Model

Model	Mean Difference	S.D.	T	Sig. 2-tailed of Paired Sample t-Test
In-In	- 1,396.511	24,308.849	- 0.445	0.658

5 Conclusion

The results of the research showed that one can use the acquired hedonic price model to predict the reasonable selling price of secondhand condominium units with the selling prices below 200,000 baht per square meter. From 140 samples used in developing the model, exploring 4 alternatives of the models, e.g. linear-linear, linear-In, In-linear, and In-In by screening 34 initial variables by experts and entering the remaining 23 variables by stepwise multiple regression analysis procedures, the result shows that In-In model is the best fitting model with 0.727 Adjusted R². Eleven variables are revealed to affect selling prices of secondhand condominium units in Bangkok, 6 variables have negative effects and 5 variables have positive effects, according to Table 4. The Paired Sample t-Test showed the insignificant difference between the mean of observation values and the mean prediction values of the selling prices of secondhand condominium units in Bangkok that confirm the accuracy of the model.

The limitation of this research is that some attributes such as the information on sale conditions such as an agreement on transfer fees or property tax were not considered in the analysis because of the unavailability of information on the websites. However, this limitation can be a trade-off with convenience in finding the input data of the model, which makes the acquired model practical to be used.

Finally, the researchers have the recommendation that in future research, one can apply a similar approach to the other specific area or price-range of condominiums so that the data may not be heterogeneous, which can impact the accuracy of the research. Additionally, one can add some new determinants from other sources of data to explore their impacts on the selling price of secondhand condominium units such as the sale condition, quantity of electrical appliances, and ratio of a number of lifts to the number of units.

6 Availability of Data and Material

Information can be made available by contacting the corresponding author.

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Dr.Kongkoon Tochaiwat is an Assistant Professor at the Faculty of Architecture and Planning, Thammasat University, Thailand. He received Ph.D. in Civil Engineering (Construction, Engineering and Management) from Chulalongkorn University, Thailand. His research focuses on real Estate Business and Development.



Phonthanat Uruhamanon holds a Bachelor of Economics with Second Class Honours, English Program, and a Master of Science Program in Innovative Real Estate Development from Thammasat University, Thailand. His career focuses on Thailand's macroeconomics and regional connectivity between Thailand, Lao PDR, and China.



Patcharida Pultawee is a Ph.D. student in the Integrated Science of Built Environment Program at Faculty of Architecture and Planning, Thammasat University, Thailand. She received her Master's Degree in Architecture Program from the Faculty of Architecture and Planning, Thammasat University, Thailand. Her research focuses on Prediction Model in Real Estate Business.



Dr.Sittichai Naksuksakul is a researcher at PTT Innovation Institute, Thailand, and a special lecturer at Faculty of Architecture and Planning, Thammasat University, Thailand. He received his Doctoral Degree in Civil Engineering from Yokohama National University, Japan. His research focuses on Innovative Technology in Construction and Real Estate Development.



Behavioural Intention of Lecturers towards Mobile Learning and the Moderating Effect of Digital Literacy in Saudi Arabian Universities

Aldhwaiyan Mohammed Saad^{1*}, Mariam Binti Mohamad¹, and Chau Kien Tsong¹

¹ Centre for Instructional Technology and Multimedia, Universiti Sains Malaysia, MALAYSIA.

*Corresponding Author (Tel: +966 50 540 7537, Mom1881@hotmail.com)

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Abstract

The widespread of personal computers and the availability of Internet connections have been the core modern-day educational tools that aid teaching and learning, and enhance effective interaction between students and their lecturers. However, despite the appreciable level of recognition of mobile learning as a new innovative educational model in the country, there exists a wide research gap as a result of implementation and adoption. This study examines the behavioral intention of lecturers towards mobile learning and the moderating effect of digital literacy in Saudi Arabian universities. A total of 420 respondents was conveniently sampled, and a structured questionnaire was designed, administered, and analyzed using SPSS®23 and PLS-SEM software. The results obtained showed a direct and significant relationship between all the variables with behavioral intention. It revealed that mobile literacy showed the highest contribution, followed by facilitating conditions, perceived usefulness, and perceived ease of use. However, only years of experience was negatively related. The result of the moderation showed that mobile literacy, moderated with facilitating conditions. Basic ICT literacy is negatively moderated with facilitating conditions and positively moderated with learning expectancy. Based on this outcome, it is recommended that universities can design a policy that will facilitate the enhancement of digital literacy, particularly mobile literacy among lecturers by building their capacity on the use of mobile learning tools for research, teaching, and learning.

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1 Introduction

The concept of mobile learning (M-learning) depends on wireless mobile devices which offer ease of accessibility and a collaborative learning atmosphere at different levels of tertiary education. The learner is not restricted within the classroom or any specific location or time. Recently, M-learning gains attention at the tertiary educational level, especially in university settings, offering mobile usage to educational resources and an effective conversation and constructive evaluation between teachers and students (Nassuora, 2012). Several universities in Saudi Arabia have adopted mobile learning (M-Learning) approaches proposed by the Saudi government and the Ministry of Higher Education. King Saud University, for example, allows its students to connect and respond to student inquiries and share information (Almutairy et al., 2015). Also, the University of King Khalid launched a coordinated digital blackboard to provide students with university announcements while using social media websites. Many other Saudi universities have signed partnership agreements to introduce M-Learning with international universities (Al-Shehri, 2013).

Moreover, mobile phones have been used by educational institutes to serve the purpose of pedagogical needs. In Saudi Arabia, such a realization of the M-Learning approach was acknowledged by the Saudi government by establishing a technological infrastructure for optimal use of information and communications technology. In 2011, Saudi Arabia allocated USD 7.2 billion of technological infrastructure to facilitate the process of M-learning. These include The National Centre for E-learning and Distance Education, JUSUR (Learn distance learning approaching Management System), Saudi Digital Library, and Saudi Electronic University (Al-Shehri, 2013).

The increased attention given to M-learning in Saudi Arabia is associated with mobile phone usage trends and its capabilities (Al-Hujran et al., 2014). It is worthy to note that the availability of mobile devices and internet connectivity alone may not necessarily be enough to achieve sustainable adoption of M-learning in tertiary institutions, especially university settings. Furthermore, despite the appreciable level of familiarity with M-Learning as a new innovative educational model in the country, there exists a wide research gap as a result of implementation and adoption-related issues among lecturers in Saudi Arabia. This study is primarily concerned about the limitation of m-learning usage among lecturers in Saudi Arabian universities. Hence, the need for in-depth research to explore the behavioural intention of lecturers towards mobile learning approaches in Saudi Arabia Universities. By exploring this concept, universities can support their academic plan currently in-use while satisfying the demand of students and lecturers. To further support the effort towards integrating technology and ICT in the teaching and learning process, However, the success of this innovation highly depends on the right leadership framework and implementation in the university, Salihu, (2019a).

2 Literature Review

Lecturers are the key players in integrating technological innovations into education (Tai, & Ting, 2011). The sustainable implementation of m-learning relies solely on its acceptability among lecturers and their belief on how well the technology would enhance learning (Al-Shehri, 2013; Al-Seghayer, 2014). According to, Mobile Learning (M-Learning) is a form of learning through mobile devices that takes place within and beyond the traditional learning settings. Mobile learning (M-Learning) could facilitate both formal and informal learning activities using wireless mobile devices with an internet connection; many scholars and educational experts believe that M-Learning is an advanced form of electronic learning (E-learning) and distance learning "D-Learning" (Abas et al., 2009).

Nonetheless, mobile learning (M-learning) is still ambiguous and requires a clear definition. Mobile learning, according to Mohamad and Woppard (2010), refers to a form of learning using mobile devices. These devices, according to the authors, maybe big devices such as web books, notebooks, and laptops computers or small devices such as mobile phones and smartwatches. Alharbi and Drew (2014), distinguished M-learning definition based on the concept of mobility of the device or the mobility of users or earners. Differently, Kambourakis, Rouskas, and Gritzalis (2004) defined the concept based on the mobility of learners or users. They articulated that M-learning is a teaching activity that takes place with the assistance of mobile technology devices.

Cheon et al. (2012) defined M-learning as any use of a mobile device that is portable, whereby this device has instant connectivity and sensitivity. This device can be carried with users and learners anywhere. The device of mobile can conduct two-way communication and gathers information disregard being in a fixed place. According to Wang et al. (2009), M-learning is defined as a means of interaction among the users and learners using mobile devices. The users refer to the lecturers, and learners refer to the students. In this study, M-learning refers to a form of learning using mobile devices in e-learning platforms, as such the proposed research is meant to expand the knowledge and the theoretical background of how to make the M-learning approach using mobile devices in Saudi Arabia to be utilized and adopted among the lecturers in Saudi Arabia Universities.

From the perspectives of different typological institutions (Salihu 2019b), the extensive literature review revealed several studies in Saudi Arabia related to the adoption and use of the M-learning approach in various settings (i.e., high schools and universities). Nassuora (2012), surveyed about 80 students at the University of Al-Faisal to examine the M-learning acceptance level. The UTAUT model was empirically tested in his research. Given the effort of the research to empirically analyze the dimensions of the UTAUT model, the drawback of this research was the small number of sample sizes and the emphasis on a single private institute to assess students' acceptance rate. Using a quantitative case study may, to some extent, limit the generalizability of the findings to other Saudi Arabia higher educational institutes. Likewise, Chanchary and Islam (2011) also assessed students' interests in the M-learning approach and asked students to rate the advantages and disadvantages of using the M-learning approach. Almutairy et al. (2014) also assessed Saudi Arabia's readiness to use M-learning technology concisely.

3 Conceptual Framework of the Study

This study was based on the Unified Theory of Acceptance and Use of Technology (UTAUT) and Technology Acceptance Model (TAM). The integration of these two theories formed the conceptual framework of the current study (Figure 1), which shows the relationship between the research variables that were integrated into the research conceptually. This study is aimed at investigating the behavioural intention of lecturers towards mobile learning approach in Saudi Arabian universities. The conceptual framework of the study as illustrated in Figure 1 shows the independent variable components with five main constructs or dimensions namely; Perceived Usefulness (PU), Facilitating Condition (FC), Perceived Ease of Use (PE), and Learning Expectancy. The dependent variable is conceptualized as Behavioral (BE) intention of Lecturers towards M-Learning whereas Digital Literacy is the mediating variable of the study, with two main constructs or dimensions namely; Basic ICT Literacy and Mobile ICT Literacy.

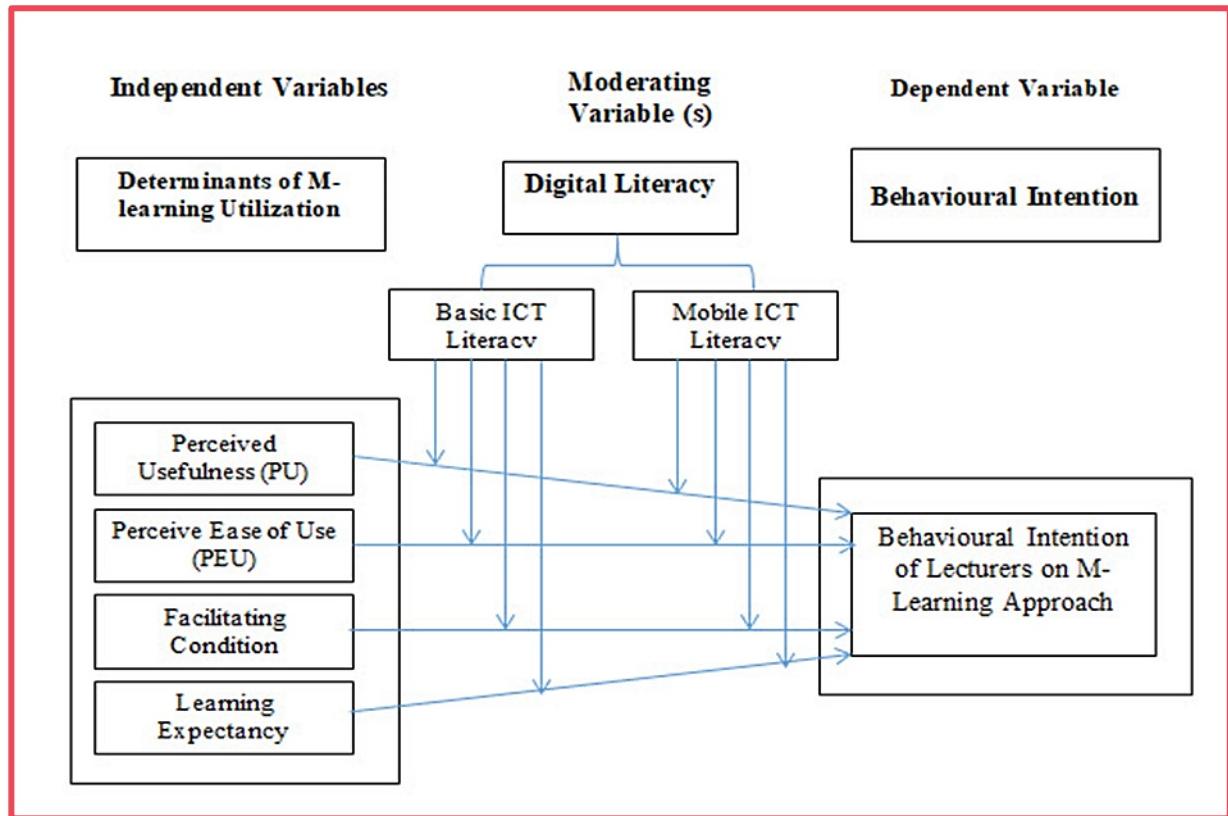


Figure 1: Conceptual framework of this study.

4 Method

4.1 Research Design

The research uses a quantitative survey design that is cross-sectional on the time horizon. According to survey research designs apply to the quantitative research method in which researchers conduct a survey to a sample or to the entire population of individuals to characterize the opinions, attitudes, behaviours, or characteristics Salihu, (2017). Furthermore, a cross-sectional time horizon was adopted because this study is limited to a specific time frame.

4.2 Population and Sampling

Many educational institutions using the M-learning approach exist throughout Saudi Arabia. Yet inquiries with the Ministry of Higher Education via Internet search revealed that more than 13 Universities and Colleges are using the M-learning approach as means of teaching and providing services (Badwelan et al. 2016; Alshammari, 2016). However, information about these institutions is not available; thus, the target population for this study comprises all the academic staff of the universities in Saudi Arabia. In this study, the target population is estimated at 63388.

Sampling design involves the use of sampling procedures and methods so that the results can be used to derive conclusions. In quantitative research, the participation of a sufficiently large number of individuals is needed. The sample size was determined using a table of sampling at 95% confidence level and 5% margin of error, based on the study population. According to the table, a population of 63,380 would have a sample size of 382. However, the literature suggested 10% be added to the minimum sample size to take care of missing and incomplete responses. The sample size for this study was 420 samples, which paved the way to take care of outliers, inadequate response, and missing values.

This study intended to use the non-probability sampling technique, a decision guided by the absence of a

total sampling frame of the respondents who are familiar with or going to use the M-learning approach. Such limitation inhibits the use of a probability sampling technique, as randomization may not become possible. In such a case, a convenient sampling non-probability technique is deemed to be an appropriate choice.

4.3 Data Collection and Analysis

The instrument used for this study was primarily a questionnaire to elicit information from the respondents. The questionnaire was adapted from the work of Hofstede (1980), Wilfong (2006), Mueller et al. (2008), Lee (2009), Venkatesh et al. (2003), Kennedy et al. (2008), and Davis (1989). Here in this study, selected and extracted only the items that are suitable for the present research according to the study variables. The questionnaires were distributed to the respondents using face to face method with the help of research assistants. Before the main data collection exercise, 10% of the study sample size determined (42) was administered for the pilot test of the instrument.

Before data collection, the questionnaire was verified by two experts from King Saud University who are specialized in English language and translation, to check the clarity of the linguistic formulation of the questionnaire phrases and the scientific accuracy of the questionnaire phrases. Finally, the obtained data were analyzed with SPSS and PLS-SEM software. This research approach designed as quantitative, this study applied structural equation modeling (SEM-PLS) to determine the association between the constructs. PLS-SEM is a widely used multivariate statistical tool to measure the direct and indirect relationships between one or more independent constructs as well as one or more dependent constructs (Chin & Todd, 1995).

5 Result And Discussion

5.1 Demographic Characteristics

The main demographic characteristics for participants of the present study include; Gender, age groups, years of work experience, qualification, workplace, and work position. Males were the majority. Participants aged 40-49 years got the highest incidence with 52.6%, followed by 30-39 years (28.8%) and 50-59 years (18.5%). Ph.D. holders got the highest incidence by 82.7%, followed by MSc and BSc (9.3% and 8%). Higher percentages of participants worked at university than colleges (91% vs 9%). Professor positions got a higher incidence than the lecturer position (88.7% vs 11.3%). Participants with years of experience longer than eight years got higher incidence than those less than eight years (62.2% vs 37.8%), as shown in Table 1.

Table 1: Demographic characteristics of this study

Variables		n.	%
Gender	Female	108	27.1
	Male	291	72.9
Age	30-39 years	115	28.8
	40-49 years	210	52.6
	50-59 years	74	18.5
Years of experience	Less than 8 years	151	37.8
	More than 8 years	248	62.2
Qualification	BSc	32	8.0
	MSc	37	9.3
	PhD	330	82.7
Workplace	University	363	91.0
	College	36	9.0
Work position	Lecturer	45	11.3
	Professor	354	88.7

5.2 Multiple Regression Analyses

To explore the direct relationship between the dependent and the predictors variable, multiple linear regression (dummy method) was used to find out the predictors of the overall score of behavioral intention for the participants of the current study. The result of the analyses as shown in Table 2 revealed that Perceived Usefulness is the most significant predictor ($p=0.005$) of behavioral intention in the model, with a positive coefficient weight value of 0.719. The second important and significant predictor of behavioral intention in the model is Mobile ICT Literacy, which has a positive coefficient weight value of 0.639 ($p< 0.001$). Another important variable in the model is the Facilitating Condition, which has a positive and significant coefficient with a weight value of 0.416 ($p< 0.001$). Perceived Ease of Use was also a positive and significant predictor of behavioral intention. However, it has less effect due to its lowest coefficient value weight value (0.155), ($p< 0.001$) in the model.

However, a significant but negative relationship was found between years of experience and behavioral intention. It has a negatively signed coefficient with a weight of -0.886, $p< 0.005$. As the comparison of contributions of predictors, mobile literacy showed the highest contribution with beta value equals to (0.533), followed by facilitating conditions (beta = 0.319), perceived usefulness (beta = 0.209), and perceived ease of use (beta = 0.095). The result further revealed that these predictors cause 74.4% (adjust R² = .744) of behavioral intention whereas the remaining 25.6%, is caused by other factors not captured in the model, which showed a perfect model.

Table 2: Predictors of Behavioural intention

Behavioral intention	Unstandardized Coefficients		Beta	t	p-value	95.0% CI for B	
	Beta	SE				Lower Bound	Upper Bound
(Constant)	3.173	1.479		2.145	.033	.264	6.081
Perceived Ease of Use	.155	.055	.095	2.819	.005	.047	.263
Perceived Usefulness	.719	.098	.209	7.320	.000	.526	.912
Facilitating Condition	.416	.046	.319	9.007	.000	.325	.507
Mobile ICT Literacy	.639	.045	.533	14.345	.000	.552	.727
Years of experience	-.886	.280	-.088	-3.167	.002	-1.437	-.336

Multiple linear regression. df (5), $p < 0.05$, $R = 0.865$ (adjust $R^2 = 0.744$), Reference: years of experience less than 8 years.

5.3 Moderators of behavioral Intention

Multiple linear regression statistical tests were also used to determine the impact of moderators on the relationship between the independent variables and behavioral intentions. Significant moderating effects of mobile literacy and basic ICT literacy with some independent variables on the behavioural intention were observed. The result in Table 3 showed that Mobile literacy significantly moderated the relationship between facilitating conditions and behavioral intention with a coefficient weight value of 0.029 (beta = 1.066), $p= 0.038$. On the other hand, Basic ICT literacy negatively moderated the relationship between facilitating conditions and the behavioral intention with a negatively coefficient weight value of -0.033 (beta = -1.154), $p= 0.022$. Lastly, Basic ICT literacy moderated the relationship between learning expectancy and behavioural intention positively with a coefficient weight value of 0.029 (beta = 1.050), $p=0.015$. However, all other relationships between the predictor variables and the behavioural intention were not moderated by digital literacy (Mobile literacy and Basic ICT literacy).

Table 3: Moderators of behavioural Intention

Behavioural intention	Unstandardized Coefficients		Beta	T	p-value	95.0% CI for B	
	Beta	SE				Lower Bound	Upper Bound
(Constant)	23.020	.700		32.871	.000	21.643	24.398
Mobile ICT literacy * perceived ease of use	.004	.020	.113	.186	.852	-.035	.043
Mobile ICT literacy* perceived usefulness	-.009	.023	-.111	-.413	.680	-.054	.035
Mobile ICT literacy* facilitating conditions	.029	.014	1.066	2.088	.038	.002	.056
Mobile ICT literacy* learning expectancy	-.009	.012	-.358	-.774	.439	-.033	.014
Basic ICT literacy * perceived ease of use	.001	.020	.003	.006	.995	-.039	.039
Basic ICT literacy* perceived usefulness	.026	.024	.300	1.107	.269	-.021	.073
Basic ICT literacy* facilitating conditions	-.033	.014	-1.154	-2.298	.022	-.061	-.005
Basic ICT literacy* learning expectancy	.029	.012	1.050	2.448	.015	.006	.052

Multiple linear regression. df (8), p <0.05, R = 0.875 (adjust R² = 0.760).

6 Conclusion and Policy Implication

The result of the current study indicated the contributions of predictors, where mobile literacy showed the highest contribution, followed by facilitating conditions, perceived, and perceived ease of use. Based on this outcome, it can be concluded that mobile literacy and facilitating conditions if enhanced, will have a significant impact on the intention of lecturers towards the adoption of mobile learning. The negative relationship that existed between years of experience and behavioural intention revealed that older lecturers that have been in the service of the universities prefer the traditional method of teaching as against the use of technology. Based on this outcome, it can be concluded that the younger lecturers in Saudi Arabian universities have more tendency and intention to adopt the use of mobile learning in their service delivery. On the moderation effect of digital literacy (mobile and Basic ICT literacy), it can be concluded that mobile literacy moderated positively. In contrast, Basic ICT literacy moderated negatively between facilitating conditions and behavioural intention. Basic ICT literacy moderated positively between Learning expectancy and behavioral intention.

Therefore, the essential policy recommendations that can be deduced from these findings is that universities may design a policy that will facilitate the enhancement of digital literacy, particularly mobile literacy among lecturers. This could be in the form of seminars, workshops, and conferences that will help in building their capacity and encourage their use of mobile learning tools for research, teaching and learning. Also, universities may facilitate the provision of mobile learning tools to lecturers, especially the older ones, in order to encourage them to adopt the use of mobile learning.

7 Availability of Data and Material

Information can be made available by contacting the corresponding author.

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Aldhwaiyan Mohammed Saad is a Ph.D. student at Centre for Instructional Technology and Multimedia, Universiti Sains Malaysia, Penang, Malaysia. He obtained his Master's degree in Teaching Techniques from King Abdulaziz University, Saudi Arabia



Dr. Mariam Mohammed is a Senior Lecturer at Centre for Instructional Technology Practices and Multimedia, Universiti Sains Malaysia. She obtained her Bachelor in Information Technology in Organization, her Master's degree in Computer Based Learning and Training, and her PhD in Education from the University of Southampton, United Kingdom.



Dr. Chau Kien Tsong is a Senior Lecturer, Centre for Instructional Technology and Multimedia, Universiti Sains Malaysia, Penang, Malaysia. He obtained his Master of Science in Information Technology from Universiti Putra Malaysia and a Ph.D. in Multimedia from Universiti Sains Malaysia, Penang, Malaysia.



Types of Trip Generation of Large Retail/Wholesale Stores in Thailand

Anothai Namwong¹, Winai Raksuntorn^{1*}, Boonsap Witchayangkoon¹,
Nareenart Raksuntorn², and Songrit Chayanan³

¹ Department of Civil Engineering, Thammasat School of Engineering, Thammasat University, THAILAND.

² Faculty of Industrial Technology, Suan Sunandha Rajabhat University, THAILAND

³ Bureau of Highway Safety, Department of Highways, Ministry of Transportation, Royal Thai Government, THAILAND.

*Corresponding Author (Email: rwinai @ engr.tu.ac.th).

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Abstract

This research study determines the types of trip generation of visitors who visit a large retailer/wholesaler, located in Bangkok and other provinces in Thailand. With the face-by-face survey, data are collected from seven retailers/wholesalers during the rush hours 16:00-19:00 on a weekday and a weekend. Studied variables are locations, number of parking spaces, areas of the large retail/wholesale stores, weekday, and weekend. Statistic analysis has been used to test relationships between variables. The result finds that types of trip generation neither depend on the shopping area size nor the number of parking spaces. This study also finds that most of the trip generations are primary trips, up to 80 percent on weekdays, and tend to increase on the weekend, while pass-by trips and diverted trips decrease.

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1. Introduction

The developments and growth of the city are rapidly expanding, resulting in more forms of trip generation. Without good planning to control the city's growth will have greater impacts, especially in terms of traffic. Supermarkets create great attractions to form trip generations of people. This is because supermarkets tend to be in areas close to crowded communities. Locations of supermarkets in Thailand are mostly on the main road network to facilitate the visitors.

However, traffic problems arise from the personal cars entering and exiting supermarkets, particularly car queueing on the main road to get entering to the parking of the supermarket/community malls (Pimcham et al., 2021). This has resulted in traffic impacts on major roads, or even causing road capacity beyond what can be accommodated. Therefore, the Traffic Impact Assessment should be performed together with business/construction permission.

1.1 Types of Trip Generation

Trip generation is used to assess the number of site-generated trips related to a given type of land use (ITE, 2020). There are three types of trip generation.

A primary trip is a form of travel that travels from the starting point to the destination and returning to the starting point, such as traveling from Home-Work-Home.

A pass-by-trip is a form of travel from one point and then stop at a point along the way before going to the destination, such as travel from Work-Retail store-Home.

A diverted trip is a form of travel from one point and making a diversion route to visit a specific point before going to the destination, such as travel from Work-Market-Home. The diverted trip is off from the normal route.

2. Literature Review

Brehmer & Butorac (2003) studied trip generation characteristics of 10 discount supermarkets in the USA. They found that trip rate and trip type associated with a major discount grocer were found to be much lower than the standard ITE grocer.

Comparing New Zealand with UK, USA, and Australia results, Abley & Douglass (2011) studied trips and parking related to land use, reviewing trip generation surveys to learn the travel patterns with daily trips by all modes and purposes. The research considered surveyed seasonal traffic and parking variations.

Steedman et al. (2016) analyzed primary, pass-by, and diverted trip data of five supermarkets in New Zealand, at three different times including weekend peak, weekday peak, and weekday off-peak. The result found that most trips are pass-by and diverted trips. They were able to discover possible factors/reasons for differences between each of the surveys. The supermarket's location affected the proportion of primary, pass-by, and diverted trips as proximity to roads with high daily traffic volumes greatly influence the trip generation. Other influent factors were the time of day, size of a supermarket, type of supermarket, and proximity of competitors.

As changes from daily shopping at fresh markets, food stalls, and local shops to modern stores (i.e. department stores, supermarkets, and hypermarkets, Panurat (2012) studied changes in consumer behavior in Thailand and investigated consumer behavior and influences affecting the choice to shop. The study found two key factors influencing consumers' choice of the mall including physical location and consumer behavior. Consumers go to community malls located in the neighborhood within 3 km distance or a 10-minute drive. Consumers prefer to go to

community malls that have plenty of parking with many types of stores including supermarkets, restaurants, cafés & bakeries, and banks.

Brahmahitadara (2010) studied trip rates and factors influencing trip rates for 15 large retailer stores in Bangkok and suburban areas. The analysis found that that trip rates and parking demands depended on the gross service areas of the retailer stores. Also, trip rates and parking demands were lowest on a weekday and highest on Sunday.

3. Method

This study focuses on the three types of trips including the primary trip, pass-by trip, and divert trip. The visitors' survey was conducted at a selected location of seven large retail and wholesale stores. The interview survey was conducted on a weekday and weekend (Saturday and Sunday) from 4 pm-7 pm (peak road traffic). This study collected data from 500 participants at each store, a total of 3500 participants from all seven stores. Statistical analysis is used to analyze the collected data.

This study also explores characteristics of the studied large retail/wholesale stores' areas and their effect on the nearby traffic. The study also observes the number of parking of each store. For example, the geo-map (Figure 1) shows the city location of TL Rangsit.



Figure 1: Geo-characteristic of TL Rangsit (geolocation 13.9936465,100.6132019).

Table 1: Location and GPS

Large retail/wholesale store	Location	Geolocation
TL Rangsit	In the city	(13.9936465,100.6132019)
TL Saraburi	In the city	(14.5218229,100.9198623)
TL Korat	In the city	(14.9789275,102.005983)
TL Khonkean	Suburban	(16.4008898,102.8140649)
BC Ayuthaya	Suburban	(14.3192691,100.6093891)
BC Chiangmai	In the city	(18.7700192,99.0313125)
MK Ramintra	In the city	(13.8113362,100.6923097)

4. Analysis and Results

4.1 Effects of Types of Trip Generation on Locations of Large Retail/Wholesale Store

This study finds the relationship between types of trip generation and large retail/wholesale locations. Most large retails/wholesalers are located in the city or suburb, on the main road network. For stores in the community city, 80 percent of types of trip generation are primary trips both on weekdays, and weekends, see Figures 2-4. For suburban locations stores, for example, TL Khon Kaen situated on the main road network that people go through to work in the city, pass-by trips are higher compared to other locations. For all cases, diverted trips are small proportions.

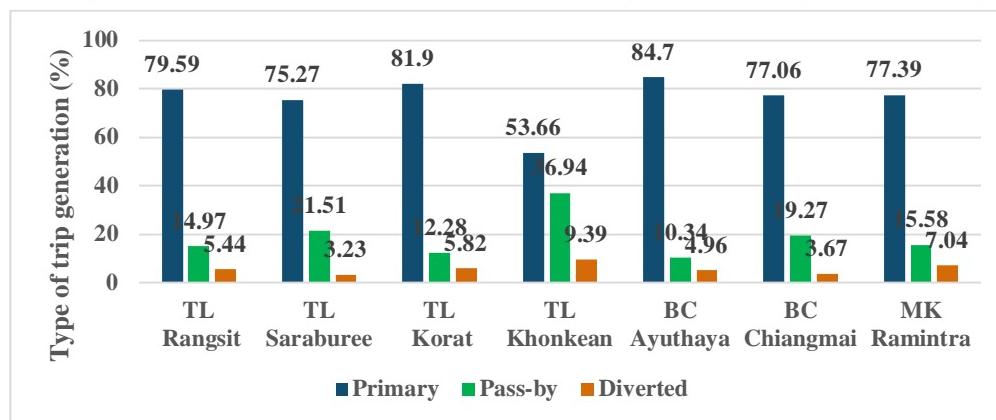


Figure 2: Proportions of types of trip generation on locations of each large retail/wholesale (weekday).

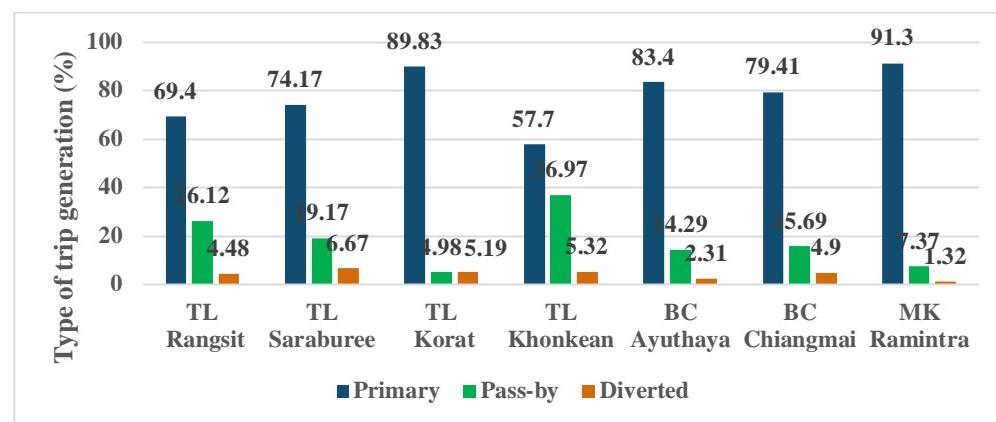


Figure 3: Proportions of types of trip generation on locations of each large retail/wholesale (Saturday)

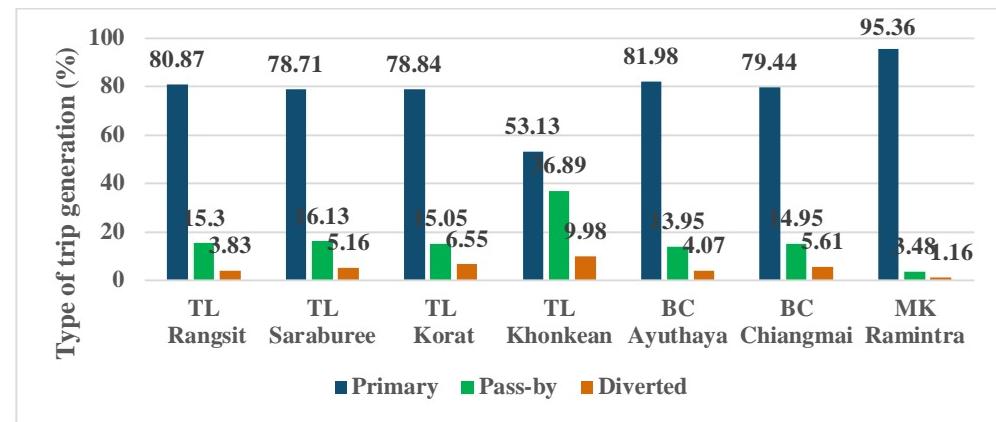


Figure 4: Correlation of travel type proportions with large retail/wholesale locations (Sunday)

4.2 Relationship of Types of Trip Generation and Store's Size and the Number of Parking Spaces

From the study results of Figures 5 and 6 on parking spaces and store's size of large retail/wholesalers, this study finds no relationship between types of trip generation and store size and the number of parking spaces on all days of the weeks.

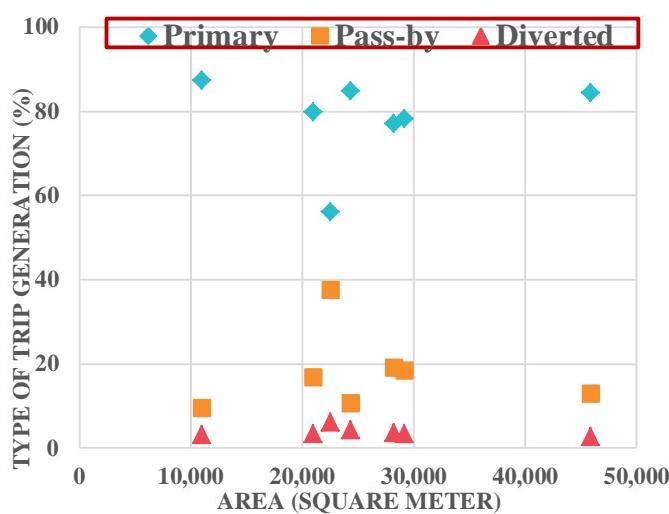


Figure 5: Types of trip generation (%) and store size.

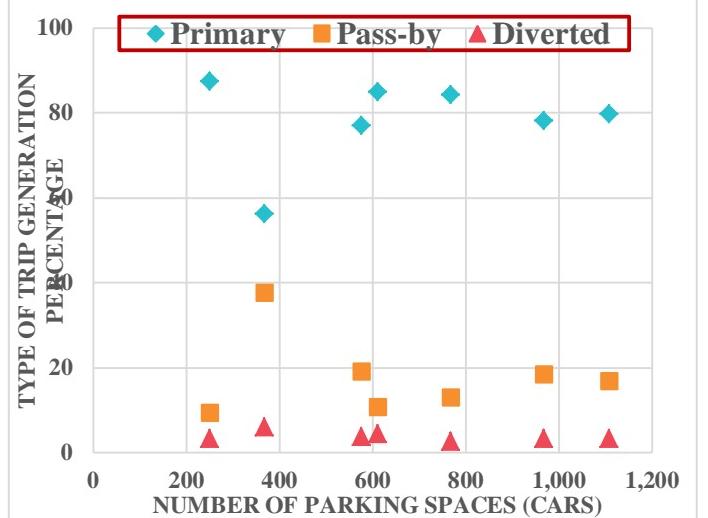


Figure 6: Types of trip generation (%) and the number of parking spaces.

4.3 Relationship of Types of Trip Generation Proportion to Day of Week

The results in Table 1 compare the statistic test that p-value less than 0.05 (given with a star) indicates the difference between the day of the week. In this study, most Saturdays are different from other days. It is observed that diverted trips on Saturdays are much lower compared to other days.

Table 2: Similarity Test Between Days of the Week

Time period 16:00 - 19:00	Between Weekday and Saturday		Between Saturday and Sunday		Between Weekday and Sunday	
	χ^2	P-value	χ^2	P-value	χ^2	P-value
TL Rangsit	16.21	<0.01*	17.93	<0.01*	1.47	0.48
TL Saraburee	6.30	0.04	2.77	0.25	6.01	0.05
TL Korat	16.16	<0.01*	26.77	<0.01*	1.75	0.42
TL Khonkean	17.59	<0.01*	16.66	<0.01*	0.10	0.95
BC Ayuthaya	7.55	0.02	2.45	0.29	3.24	0.20
BC Chiangmai	2.73	0.26	0.30	0.86	4.25	0.12
MK Ramintra	43.61	<0.01*	17.93	<0.01*	63.29	<0.01*

4.4 Relationship of the Proportion of Types of Trip Generation to the Date of the Place

For location comparisons on weekdays Table 3, it is clearly seen that there are differences between stores located in city and suburban areas, that primary trips to store in the city (TL Rangsit, Saraburee, Korat, BC Chiangmai, and MK Ramintra) is higher than that of stores in suburban.

For location comparisons on Saturday Table 4, the results tend to be different between stores for all locations both city and suburban areas.

For location comparisons on Sunday Table 5, the results are similar to those on the weekdays except and MK Ramintra. This is due to that TL Khonkean is located on the suburban main road network linking suburban and the city. For MK Ramintra, this wholesale store has its specific characteristics to have up to 90% primary trips.

Table 3: P-values for location comparisons on weekdays.

Location	TL Rangsit	TL Saraburee	TL Korat	TL Khonkean	BC Ayuthaya	BC Chiangmai	MK Ramintra
TL Rangsit	-						
TL Saraburee	0.02	-					
TL Korat	0.50	<0.01*	-				
TL Khonkean	<0.01*	<0.01*	<0.01*	-			
BC Ayuthaya	<0.01*	<0.01*	0.52	<0.01*	-		
BC Chiangmai	0.13	0.68	0.01	<0.01*	<0.01*	-	
MK Ramintra	0.54	<0.01*	0.20	<0.01*	<0.01*	0.03	-

Table 4: P-values for location comparisons on Saturday

Location	TL Rangsit	TL Saraburee	TL Korat	TL Khonkean	BC Ayuthaya	BC Chiangmai	MK Ramintra
TL Rangsit	-						
TL Saraburee	0.03	-					
TL Korat	<0.01*	<0.01*	-				
TL Khonkean	<0.01*	<0.01*	<0.01*	-			
BC Ayuthaya	<0.01*	<0.01*	<0.01*	<0.01*	-		
BC Chiangmai	<0.01*	0.14	<0.01*	<0.01*	0.07	-	
MK Ramintra	<0.01*	<0.01*	<0.01*	<0.01*	<0.01*	<0.01*	-

Table 5: Correlation of the proportion of types of the trip generation with Sunday

Location	TL Rangsit	TL Saraburee	TL Korat	TL Khonkean	BC Ayuthaya	BC Chiangmai	MK Ramintra
TL Rangsit	-						
TL Saraburee	0.53	-					
TL Korat	0.16	0.64	-				
TL Khonkean	<0.01*	<0.01*	<0.01*	-			
BC Ayuthaya	0.81	0.42	0.19	<0.01*	-		
BC Chiangmai	0.42	0.86	0.84	<0.01*	0.47	-	
MK Ramintra	<0.01*	<0.01*	<0.01*	<0.01*	<0.01*	<0.01*	-

5. CONCLUSION

This study focuses on three types of trip generation in Thailand including primary trips (travel from the origin to the destination and back to the origin), pass-by trip (travel from one point and stop at one point as a pass-by point before going to the destination), and diverted trip (travel from a point and stop at a point and go to the destination on a different route).

Data collected from large retail/wholesalers visitors shows trips' habits that primary trips are the highest trip generation. Store size and the number of parking do not affect the types of trip generation. Large wholesalers have the highest primary trips (80-90% of everyday trips).

Typically, for all large retail/wholesalers stores, primary trips are 70-80% while pass-by trips 6-25% for every day of the week. Locations of large retail/wholesalers stores having high pass-by trips are on the suburban road network.

6. Availability of Data, and Material

Data can be made available by contacting the corresponding author.

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Anothai Namwong is a Master's degree student of the Department of Civil Engineering, Thammasat School of Engineering, Thammasat University, THAILAND. He earned a Bachelor of Engineering (Civil Engineering), Thammasat School of Engineering, Thammasat University. He is interested in Traffic Modeling Analysis and Management.



Dr. Winai Raksuntorn received his PhD (Civil Engineering) from the University of Colorado, USA. He is an Assistant Professor in the Department of Civil Engineering, Thammasat School of Engineering, Thammasat University. His research interests include Transportation Safety Analysis, Traffic Operations and Management, Traffic Impact Studies, Traffic Flow Modeling, Highway Capacity Analysis, Advanced Traffic Management for Intelligent Transportation Systems.



Dr. Boonsap Witchayangkoon is an Associate Professor at the Department of Civil Engineering, Thammasat School of Engineering, Thammasat University. He received his B.Eng. from the King Mongkut's University of Technology Thonburi with Honors. He continued his PhD study at the University of Maine, USA, where he obtained his PhD in Spatial Information Science & Engineering. Dr. Witchayangkoon's interests involve Applications of Multidisciplinary and Emerging Technologies to Engineering.



Dr. Nareenart Raksuntorn is an Assistant Professor at the Faculty of Industrial Technology, Suan Sunandha Rajabhat University. She received the B.Eng. degree in Electronics Engineering from King Mongkut's Institute of Technology Ladkrabang, Thailand, the M.S. degree in Electrical Engineering from the University of Colorado, and the Ph.D. degree in Electrical Engineering from the Department of Electrical and Computer Engineering, Mississippi State University. Her research interests include Remote Sensing Image Analysis, Image Processing, and Pattern Recognition.



Dr. Songrit Chayanan is Head of Traffic and Transportation Surveys, Bureau of Highway Safety, Department of Highways, Thailand. He earned his Bachelor of Engineering degree with Honors from Thammasat University, Thailand. He got his PhD from the University of Washington, USA. His research is related to the Analysis of Highways Transportation and Accidents.



An Approximate Analytical Solution of Non-Linear Fractional-Order Constrained Optimization Problem Using Optimal Homotopy Analysis Method

Oluwaseun Olumide Okundalaye¹, Wan Ainun Mior Othman^{1*}

¹ Institute of Mathematical Sciences, Faculty of Science, University of Malaya, MALAYSIA.

*Corresponding Author (Email: [wanainun@um.edu.my](mailto:wainun@um.edu.my))

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 Penalty Function;
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 Convergence-Control Parameters; Homotopy Analysis Method.

Abstract

We present an optimal homotopy analysis method (OHAM) to find an accurate approximate analytic solution (AAS) for non-linear fractional-order constrained optimization problem (FOCOP). The previous analytical approximate method (AAM) of solving FOCOP possesses no norms for the convergence of the infinite series solution. OHAM provides an independent way of choosing proper values of the control-convergence parameter (CCP), auxiliary linear operator, and enables us to control and govern the convergence area of the series solution produced by a squared residual error optimization technique. Numerical comparisons of OHAM with Runge-Kutta fourth-order (RK4) method for accuracy. Some examples from the CUTER library were used to indicate the correctness and relevance of the suggested techniques.

Disciplinary: Mathematics.

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1 Introduction

In optimization, different methods had been considered by several authors for solving constrained non-linear programming optimization problems in a class of integer-order systems of ordinary differential equations (ODEs). The gradient-based steepest descent approach is a solution method. The procedure converts a non-linear problem of optimization to systems of non-linear ODE dynamic with optimality requirements to get optimal solutions (Franceschi et. Al., 2017).

The computation of fractional-order began receiving much importance in the area of applied science some years back. Some authors in optimization focused on improving AAM for solving

various forms of arbitrary-order gradient-based dynamic systems from optimization problem: Such as a fractional dynamics trajectory approach (Evirgen and Özdemir, 2012), fractional steepest descent approach (Pu et al., 2013), an arbitrary gradient-based system using VIM (Evirgen, 2016), and a conformable fractional gradient-based system (Evirgen, 2017).

One-step OHAM was developed by Niu and Wang (2010) for non-linear differential equations(NLDEs). Liao (2010) proposed OHAM strong NLDEs to obtain an optimal convergence-control parameter by using optimization a method called squared residual error, which was integrated into the whole region of the governing equation for accurate optimal convergence-control parameters. OHAM approach has still not been implemented in solving non-linear FOCOP, which motivates this study.

2 Preliminaries

We begin by defining some particular functions and properties of fractional calculus (Abdeljawad, 2015).

Definition 1

Let $g: [0, \infty) \rightarrow \mathbb{R}$ be a given function. The β^{th} order conformable fractional derivative operator of g given by

$$T^\beta(g)(x) = \lim_{\epsilon \rightarrow 0} \frac{g(x+\epsilon x^{1-\beta}) - g(x)}{\epsilon} \quad (1),$$

$\forall x > 0$ and $\beta \in (0, 1]$.

Theorem 1

The function $\frac{d^\beta g}{dx^\beta} = x^{1-\beta} \frac{dg}{dx}$, if g is differentiable, $0 < \beta \leq 1$, and (f, g) be β -differentiable at a point $x > 0$.

Definition 2

Given that the integral is the regular Riemann improper, then we have

$$I_a^\beta(g)(x) = I_a^1(x^{\beta-1}g) = \int_a^x \frac{g(t)}{t^{1-\beta}} dt, \text{ where } t, \text{ and } \beta \in (0, 1].$$

Theorem 2

$T^\beta I_a^\beta(g)(x) = g(x)$, given that g is a continuous function in the domain of I^β and $x \geq a$.

Theorem 3

Let $g: (a, b) \rightarrow \mathbb{R}$ be differentiable and $0 < \beta \leq 1$. And so for all $x > a$, we have

$$I_a^\beta T^\beta(f)(x) = g(x) - g(a).$$

Taking non-linear programming, constrained optimization problem (NLPCOP) of the figure

$$\min_{x \in \mathbb{R}^n} g(x) \text{ subject to } \psi_k(x) \leq 0 \text{ and } h_k(x) = 0 \quad \forall k \in \mathbb{R}. \quad (2),$$

where $g: \mathbb{R}^n \rightarrow \mathbb{R}$, $\psi_k: \mathbb{R}^n \rightarrow \mathbb{R}$, and $h_k: \mathbb{R}^n \rightarrow \mathbb{R}$, $k \in \mathbb{R}$, are C^2 functions. Let $X_0 = \{x \in \mathbb{R}^n | h_k = 0, \psi_k \leq 0, k \in \mathbb{R}\}$ be the feasible set of Equation (2), and X_0 is a set of functions. An efficient penalty function of Equation (2) is given as

$$P_{penalty}(h_k(x)) = \varrho \frac{1}{\sigma} \sum_{k=1}^p (h_k(x))^{\sigma}, \quad (3),$$

$$P_{penalty}(\psi_k(x)) = \varrho \sum_{k=1}^p (\max\{0, \psi_k(x)\})^{\sigma}. \quad (4),$$

where $\sigma = 2$. It can be understood from previous research that the solution to Equation (2) is of the unconstrained form given as

$$\min G(x, \varrho) = g(x) + \varrho \left(\frac{1}{\sigma} \sum_{k=1}^p (h_k(x))^{\sigma} + \sum_{k=1}^p (\max\{0, \psi_k(x)\})^{\sigma} \right) \quad (5),$$

subject to $x \in \Re^n$

where $\varrho > 0$ is an auxiliary penalty variable (Nguyen et al., 2019).

Using Equation (1) and Equation (2) for problem Equation (5) with $\sigma = 2$, the conformable operator gradient-based dynamic model is formulated as

$$T^{\beta} x_t = -\nabla_x G(x, \varrho). \quad (6),$$

with the given initial conditions

$$x_k(0) = x_{k0} \quad k = 1 \dots n. \quad (7),$$

where $\nabla_x G(x, \varrho)$ is the gradient vector and $x \in \Re$. This form of optimization problem solution was first introduced in Evirgen and Özdemir (2011).

Note that a point x_e it is an equilibrium point of Equation (6) if it correspondent to the right-hand side of Equation (6). We reformulate the arbitrary-order dynamic system Equation (6) as

$$T^{\beta} x_k(t) = g_k(t, \varrho, x_1, x_2 \dots x_n), \quad k = 1, 2 \dots n \quad (8).$$

3 Methodology

We solve Equation (8) by constructing homotopy of the form

$$T^{\beta} x_k(t) = p g_k(t, \varrho, x_1, x_2 \dots x_n) \quad (9),$$

where $k = 1, 2 \dots n$, and $p \in [0, 1]$. If $p = 0$, Equation (9) becomes

$$T^{\beta} x_k(t) = 0. \quad (10)$$

and when $p = 1$, the homotopy Equation (9)

$$T^{\beta} x_k(t) = g_k(t, \varrho, x_1, x_2 \dots x_n) \quad t \geq 0, \quad 0 < \beta \leq 1. \quad (11)$$

with given initial conditions

$$x_k(0) = a_k, \quad k = 1, 2 \dots n \quad (12).$$

From (Liao, 2010), we formulate the zeroth-order deformation equations

$$(1 - q) \ell_k [T^{\beta} \phi_k(t, q) - x_{k0}(t)] = q \hbar_k [T^{\beta} \phi_k(t, q) - g_k(t, \varrho, \phi_1(t, q), \phi_2(t, q) \dots \phi_n(t, q))] \\ k = 1, 2 \dots n \quad (13),$$

where $q \in [0, 1]$ is an enclosed parameter, ℓ_k Are auxiliary linear operators satisfying $\ell_k(0) = 0$, $x_{k0}(t)$ are guessing approximation $x_k(t)$, $\hbar_k \neq 0$ are converging-control parameters, and $\phi_k(t, q)$ are unknown functions, when $q = 0$, and $q = 1$ we have

$$\phi_k(t, 0) = x_{k0}(t), \quad \phi_k(t, 1) = x_k(t) \quad k = 1, 2, 3 \dots n \quad (14).$$

Thus, as q increasing from 0 to 1, the solution $\phi_k(t, q)$ ranges from the initial guess $x_{k0}(t)$ to the solutions $x_k(t)$. Expand $\phi_k(t, q)$ in a Taylor series for q , we have

$$\phi_k(t, q) = x_{k0}(t) + \sum_{m=1}^{\infty} x_{km}(t)q^m \quad (15),$$

where

$$x_{km}(t) = \frac{1}{m!} \frac{\partial^m \phi_k(t, q)}{\partial q^m} \Big|_{q=0}, \quad (16).$$

If the auxiliary linear operators ℓ_k , Convergence-control parameters \hbar_k , And the guess approximation $x_{k0}(t)$, are correctly selected, then the series Equation (15) converges at $q = 1$, one has

$$x_k(t) = x_{k0}(t) + \sum_{m=1}^{\infty} x_{km}(t) \quad k = 1, 2, 3 \dots n \quad (17).$$

As proposed by Odibat (2019), differentiating Equation (13) m -times with respect to the enclosed parameter q , and equating $q = 0$, and finally subdivide them by $m!$ we have the m th-order equation as

$$\ell_k[x_{km}(t) - \chi_m x_{m-1}(t)] = \hbar_k \mathfrak{R}_{km}(\tilde{x}_{k(m-1)}(t)) \quad (18),$$

where

$$\mathfrak{R}_{km}(\tilde{x}_{k(m-1)}(t)) = \frac{1}{(m-1)!} \frac{\partial^{m-1}}{\partial q^{m-1}} [T^\beta \phi_k(t, q) - g_k(t, \varrho, \phi_1(t, q), \phi_2(t, q)\phi_n(t, q))] \quad k = 1, 2, \dots n \quad (19),$$

with

$$\chi_m = \begin{cases} 0 & m \leq 1 \\ 1 & m > 1. \end{cases}$$

Multiply both sides of Equation (18) by ℓ_k^{-1} and choose

$$\ell_k^{-1} = I^\beta \quad k = 1, 2 \dots n.$$

We have

$$x_{km}(t) = \chi_m x_{k(m-1)}(t) + \hbar_k I^\beta [\mathfrak{R}_{km}(\tilde{x}_{k(m-1)}(t))] \quad (20).$$

The m th-order Equation (18), which is linear, can be determined by any symbolic computation Maple software. From Equation (20), we get a power series solution

$$x_k(t) = \sum_{m=0}^{\infty} x_{km}(t) \quad 1 \leq k \leq n \quad (21).$$

When $m \rightarrow \infty$ in Equation (21), we can get an accurate AAS of Eq. (3.4). The traditional approach to get interval values for convergence-control parameters \hbar_k Is to plot the \hbar_k -Curve by drawing a curve of a certain proportion versus \hbar_k . Afterward, it was found that the traditional approach could not yield optimal values as declared by (Liao, 2010), which made (Odibat, 2020)

suggesting an optimization method for the optimal value of CCP by using squared residual error. Power series solution Equation (21) relies upon the convergence-control parameter vector.

The squared residual error in the m th-order of AAS is given as

$$\Delta(\hbar_1, \hbar_2) = \sum_{j=1}^2 \int_{\Omega} (N_j [\sum_{k=0}^m x_1, \sum_{k=0}^m x_2])^2 d\Omega. \quad (22).$$

denotes the square residual error of the governing equation Equation (2) at the m th-order of approximation, where $m=1, 2$, and so on. At the first-order of an estimate, the squared residual error Δ_k are depending on \hbar_k and the optimal values for \hbar_k are obtained by solving non-linear algebraic equations

$$\frac{\partial \Delta(\hbar_k)}{\partial \hbar_k} = 0 \quad k = 1, 2, \dots, n. \quad (23).$$

3.1 The Convergence Analysis

Theorem 1. As long as the series $x_k(t) = x_{k0}(t) + \sum_{m=1}^{\infty} x_{km}(t)$ for $k = 1, 2, 3, \dots, n$ converges where $x_{km}(t)$ is governed by Equation (18) under the definition Equation (19), it must be the result of Equation (11).

Proof: If we consider $\sum_{m=1}^{\infty} x_{km}(t)$ for $k = 1, 2, 3, \dots, n$ converges to $x_k(t)$ then

$$\lim_{m \rightarrow \infty} x_{km}(t) = 0 \quad \forall \quad k = 1, 2, \dots, n \quad (24).$$

We can write

$$\sum_{m=1}^{\infty} \hbar_k \mathfrak{R}_{km} (\tilde{x}_{k(m-1)}(t)) = \sum_{m=1}^{\infty} \ell_k [x_{km}(t) - \chi_m x_{m-1}(t)], \quad (25)$$

$$= \lim_{n \rightarrow \infty} \sum_{m=1}^n \ell_k [x_{km}(t) - \chi_m x_{m-1}(t)], \quad (26)$$

$$= \ell_k x_{11}(t) + (\ell_k x_{22}(t) - \ell_k x_{21}(t)) + (\ell_k x_{nn}(t) - \ell_k x_{n(n-1)}(t)), \quad (27)$$

$$= \ell_k \left[\lim_{n \rightarrow \infty} \sum_{m=1}^n x_{nn}(t) \right], \quad (28)$$

$$= \ell_k \left[\lim_{n \rightarrow \infty} x_{nn}(t) \right] = 0 \quad \forall \quad k = 1, 2, \dots, n. \quad (29).$$

Since $\hbar_k \neq 0$,

$$\mathfrak{R}_{km} (\tilde{x}_{k(m-1)}(t)) = 0. \quad (30)$$

Hence, using the above

$$\begin{aligned} \sum_{m=1}^{\infty} \mathfrak{R}_{km} (\tilde{x}_{k(m-1)}(t)) &= \sum_{m=1}^{\infty} [T^\beta x_{k(m-1)} - g_k(t, \varrho, x_{1(m-1)}, x_{2(m-1)}, \dots, x_{n(m-1)})] \\ &= \sum_{m=1}^{\infty} T^\beta x_{k(m-1)} - \sum_{m=1}^{\infty} g_k(t, \varrho, x_{k(m-1)}) \end{aligned} \quad (32)$$

$$= T^\beta x_k t - g_k(t, \varrho, x_k(t)) \quad (33).$$

From Equations (30) and (33), we have

$$T^\beta x_k(t) = g_k(t, \varrho, x_k(t)) \quad \forall \quad k = 1, 2, \dots, n \quad (36)$$

4 Numerical Examples and Results

Example 1: We consider test problem from (Schittkowski, 2012) [No 216]

$$\text{minimize } g(x) = 100(x_1^2 - x_2)^2 + (x_1 - 1)^2 \quad (37),$$

$$\text{subject to } h(x) = x_1(x_1 - 4) - 2x_2 + 12 = 0 \quad (38),$$

$$x_0 = (0, 0) \quad (39),$$

whose analytical solution is unknown, but the intended optimal solution is $x_1^* = 1.9993, x_2^* = 3.9998$. From Equation (5), we have

$$G(x, \varrho) = 100(x_1^2 - x_2)^2 + (x_1 - 1)^2 + \frac{1}{2}\varrho(x_1(x_1 - 4) - 2x_2 + 12)^2 \quad (40).$$

Similarly from Equation (6), for $\varrho = 200$ gives

$$T^\beta x_1(t) = -400(x_1^2 - x_2)x_1 - 2(x_1 - 1) - \varrho(2x_1 - 4)(x_1^2 - 4x_1 - 2x_2 + 12) \quad (41),$$

$$T^\beta x_2(t) = 200(x_1^2 - x_2) + 2\varrho(x_1^2 - 4x_1 - 2x_2 + 12) \quad 0 < \beta \leq 1, \quad (42),$$

$$x_1(0) = 0, \quad x_2(0) = 0 \quad (43).$$

Chosen a linear operator of the form

$$\ell_k^{-1} = I^\beta, \quad k = 1, 2, \dots, n,$$

According to the formula Equation (19), we have

$$\begin{aligned} \mathfrak{R}_{1m}(\tilde{x}_{1(m-1)}(t), \tilde{x}_{2(m-1)}(t)) &= T^\beta x_{1[m-1]} - 2000 \sum_{k=0}^{m-1} x_{1[m-1-k]} \sum_{j=0}^n x_{1[k-j]} x_{1[j]} - \\ &9600 \sum_{k=0}^{m-1} x_{1[m-1-k]} x_{1[K]} + 3200 x_{1[m-1]} + 3600 x_{1[m-1]} x_{2[m-1]} + 6400 x_{2[m-1]} - \\ &38402(1 - \chi_m), \end{aligned} \quad (44),$$

$$\begin{aligned} \mathfrak{R}_{2m}(\tilde{x}_{1(m-1)}(t), \tilde{x}_{2(m-1)}(t)) &= T^\beta x_{2[m-1]} - 1800 \sum_{k=0}^{m-1} x_{2[m-1-k]} x_{2[k]} - 3200 x_{1[m-1]} - \\ &1800 x_{2[m-1]} + 9600(1 - \chi_m), \end{aligned} \quad (45)$$

and the m th -order for $m \geq 1$ become

$$x_{1m}(t) = \chi_m x_{1[m-1]}(t) + \hbar_1 I^\beta [\mathfrak{R}_{1m}(\overline{\tilde{x}_1}_{[m-1]}(t))] \quad (46),$$

$$x_{2m}(t) = \chi_m x_{2[m-1]}(t) + \hbar_2 I^\beta [\mathfrak{R}_{2m}(\overline{\tilde{x}_2}_{[m-1]}(t))] \quad (47).$$

From Equation (46) and Equation (47) above, we generate symbolic series solutions for Equation (41) and Equation (42) as:

$$x_1(1) = 38402\hbar_1 t, \quad (48)$$

$$x_2(1) = 9600\hbar_2 t, \quad (49)$$

$$x_1(2) = 4.423910400 \times 10^1 1 \hbar_2 t^3 \hbar_1^2 + \hbar_1 (-6.144704020 \times 10^8 \hbar_1 + (3.0720000 \times 10^7 \hbar_2) t^2 + 38402 \hbar_1 t + \dots) \quad (50)$$

$$x_2(2) = 9600 \hbar_2 t + 8727.272727 \hbar_2^2 t^{\frac{11}{10}} - 9.6005000 \times 10^7 \hbar_2 t^2 \hbar_1 \quad (51)$$

From Equation (22), the "optimal values" of (\hbar_1, \hbar_2) is estimated by

$$\frac{\partial \Delta(\hbar_1, \hbar_2)}{\partial \hbar_1} = 0, \frac{\partial \Delta(\hbar_1, \hbar_2)}{\partial \hbar_2} = 0 \quad (52).$$

It is found that

$$\begin{aligned} \Delta_1(1) &= 1.636236158 \times 10^{16} - 7.612634534 \times 10^{20} \hbar_1 - 2.171187483 \times 10^{25} \hbar_1^2 - \\ &2.004277445 \times 10^{28} \hbar_1^3 - 8.154151650 \times 10^{19} \hbar_2 + 1.409110792 \times 10^{24} \hbar_1 \hbar_2 \end{aligned} \quad (53)$$

$$\Delta_2(1) = 1.414477488 \times 10^{15} + 2.038537912 \times 10^{19} \hbar_2 \quad (54)$$

Our calculations indicated that, $\Delta_1(3)$ and $\Delta_2(3)$ has its minimum values at

$$\Delta_1(3) = -2.149 \times 10^7 \text{ and } \Delta_2(3) = -2.678 \times 10^{11}.$$

and we have $\hbar_1 = 0.1041094886$, $\hbar_2 = -0.6938686201$ that gives an optimal solution to the problem

Example 2: We consider test problem from (Schittkowski, 2012) [No 1]

$$\text{minimize } g(x) = 100(x_2 - x_1^2)^2 + (1 - x_1)^2 \quad (55)$$

$$\text{subject to } \psi(x) = 1.5 \leq x_2 \quad (56)$$

$$x_0 = (-2, 1) \quad (57)$$

whose analytical solution is unknown, but the intended optimal solution is $x_1^* = 1$, $x_2^* = 1$. From Equation (5), we have

$$G(x, \varrho) = 100(x_2 - x_1^2)^2 + (1 - x_1)^2 + \varrho(\max\{0, -1.5 - x_2\})^2 \quad (58)$$

Taking the differentiation of Equation (58), we have

$$T^\beta x_1(t) = -400x_1^3 + 400x_1x_2 - 2x_1 + 2, \quad (59)$$

$$T^\beta x_2(t) = 200x_1^2 - 200x_2, \quad (60)$$

$$x_1(0) = 0, x_2(0) = 0. \quad (61)$$

Following the same procedure above, we have

$$x_1(1) = -794\hbar_1 t, \quad (62)$$

$$x_2(1) = 600\hbar_2 t, \quad (63)$$

$$\begin{aligned} x_1(2) &= -8.069580800 \times 10^{12} \hbar_1^4 \hbar_2 t^5 + 1.260872000 \times 10^8 \hbar_1^4 t^4 - 1.479028739 \times \\ &10^8 t^{\frac{31}{10}} \hbar_1^4 + \dots \end{aligned} \quad (64)$$

$$x_2(2) = (-60000\hbar_2^2 + 317600\hbar_1\hbar_2)t^2 + 545.4545455\hbar_2^2 t^{\frac{11}{10}} + 600\hbar_2 t \quad (65)$$

and so on.

Our estimation showed that $\Delta_1(3)$ and $\Delta_2(3)$ has its minimum results at

$$\Delta_1(3) = -0.149 \times 10^{17}, \Delta_2(3) = 0.124 \times 10^{11}.$$

The optimal value of \hbar_1, \hbar_2 Are determine as $\hbar_1 = -0.05346$ and $\hbar_2 = 0.07546$.

Table 1: The relation and absolute error among (OHAM, $\beta = 1$) and (RK4, $\beta = 1$) solutions, of **example 1**.

t_k	OHAM $x_1(t)$	OHAM $x_2(t)$	RK4 $x_1(t)$	RK4 $x_2(t)$	Abs error $x_1(t)$	Abs error $x_2(t)$
0.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.0005	1.970111	3.871642	1.970899	3.871887	0.000788	0.000245
0.0010	1.977113	3.907789	1.978274	3.907993	0.001161	0.000204
0.0015	1.981099	3.922324	1.981384	3.922554	0.000285	0.00023
0.0018	1.982155	3.930478	1.983132	3.930578	0.000977	0.00010
0.0020	1.993105	3.995556	1.994252	3.995654	0.001147	0.000098

Tables 1 and 2 show the analytical approximate and numerical values, for **example1**, and **example 2** at a different time (t). It can be understood that the analytical approximate and numerical values are in close correspondence with a deficient absolute error, which makes OHAM an excellent method to solve non-linear FOCOP.

Table 2: The relation and absolute error among (OHAM, $\beta = 1$) and (RK4, $\beta = 1$) solutions of **example 2**.

t_k	OHAM $x_1(t)$	OHAM $x_2(t)$	RK4 $x_1(t)$	RK4 $x_2(t)$	Abs error $x_1(t)$	Abs error $x_2(t)$
0.0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2.0	0.156230	0.023457	0.161481	0.023694	0.005251	0.000237
4.0	0.691769	0.578784	0.693706	0.579773	0.001937	0.000989
6.0	0.830467	0.788985	0.830548	0.789065	8.1E-05	8E-05
8.0	0.917518	0.970234	0.927053	0.970426	0.009535	0.000192
10.0	0.997398	0.987894	0.998826	0.993629	0.001428	0.005735

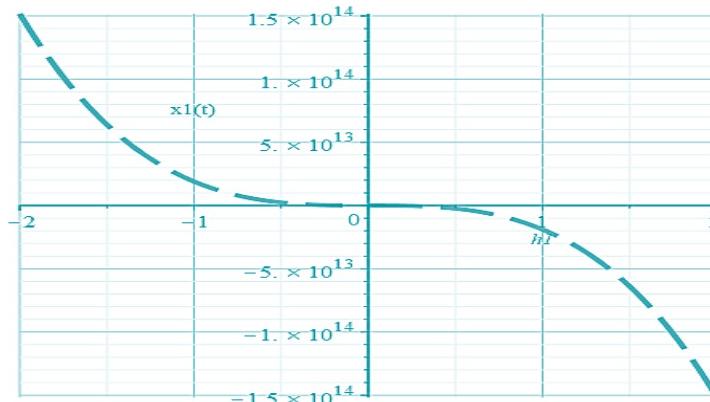


Figure 1. The h_1 -curve of OHAM for example 1 at ($t=0.005$) of $x_1(t)$.

The h_1 -curve in Figure 1 shows the convergence domain of the solution of **example 1**, between an interval of $-0.5 < \hbar_1 < 0.5$ at $x_1(t)$ and provides a clear region of the optimal values for the convergence of the proposed solution method. Figure 2 shows the domains of convergence of the series solution given by h_2 at $x_2(t)$ of example 1 and provided a clear region of the optimal values for the convergence of the proposed solution method.

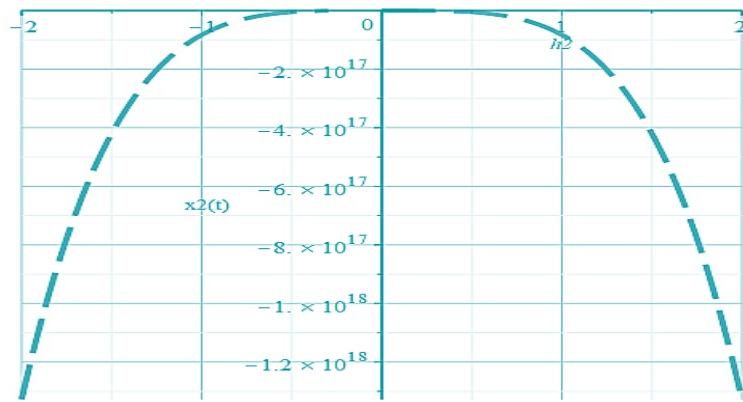


Figure 2: The h2-curve of OHAM for example 1 at ($t=0.005$) of $x_2(t)$.

Figures 3 and 4 shows mathematical simulations of the proposed method at $x_1(t)$ and $x_2(t)$ of example 1, respectively. The mathematical simulation illustrates OHAM solution as an excellent tool to solve the problem.

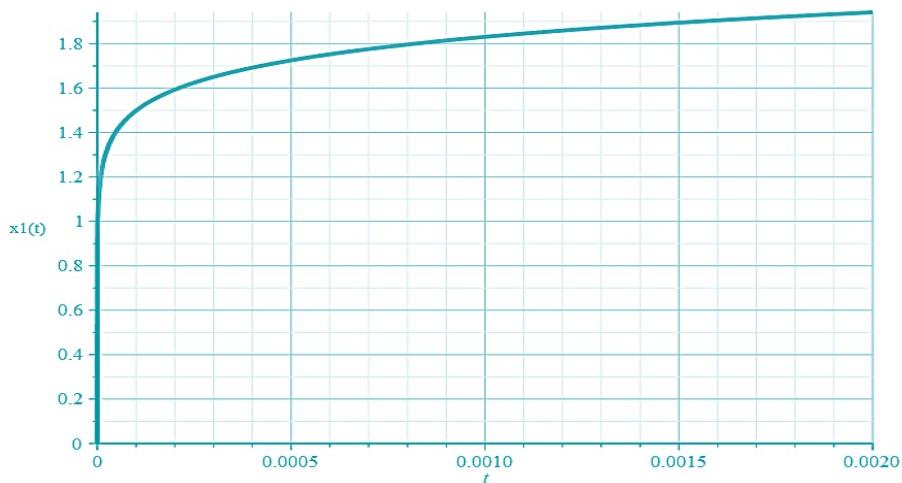


Figure 3. The mathematical simulation of OHAM solution for $\beta=0.9$ of **example 1** at the third-order approximation of $x_1(t)$.

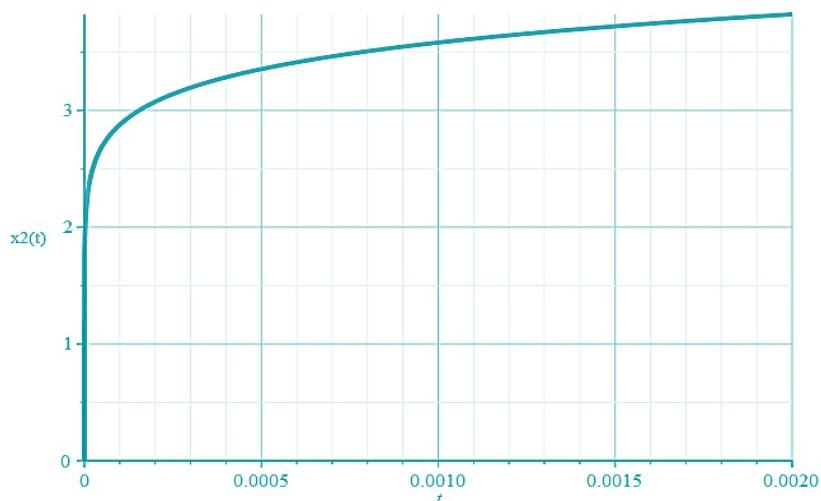


Figure 4. The mathematical simulation of OHAM solution for $\beta=0$. For **example 1** at the third-order approximation of $x_2(t)$.

Figures 5 and 6 shows the comparisons between different values of OHAM and RK4 method for justification at $x_1(t)$ and $x_2(t)$ of example 1. The comparison shows that OHAM would perform fast convergence to the optimal solutions. From Figure 6, the solution from OHAM is very precise with the expected optimal solution as the values of ($\beta=1$) approaches 1. The h_1 -curve in Figure 7 shows the domain of convergence of the series solution of example 2, between an interval of $-1 < h_1 < 1$ at $x_1(t)$.

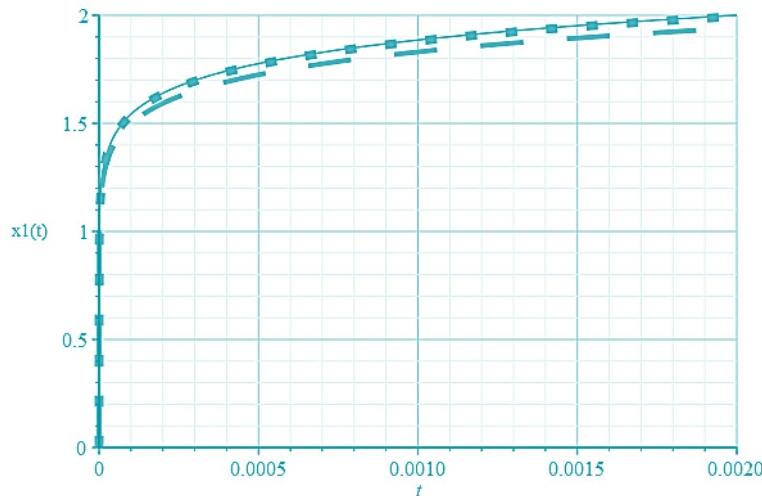


Figure 5. Comparisons between OHAM ($\beta = 0.9$, space dash, $\beta = 1$, dot) and RK4 ($\beta = 1$, solid) at $x_1(t)$ of **example 1**. It is seen in figure 5 that the solution from OHAM is very precise with the expected optimal solution as the values of ($\beta=1$) approaches 1.

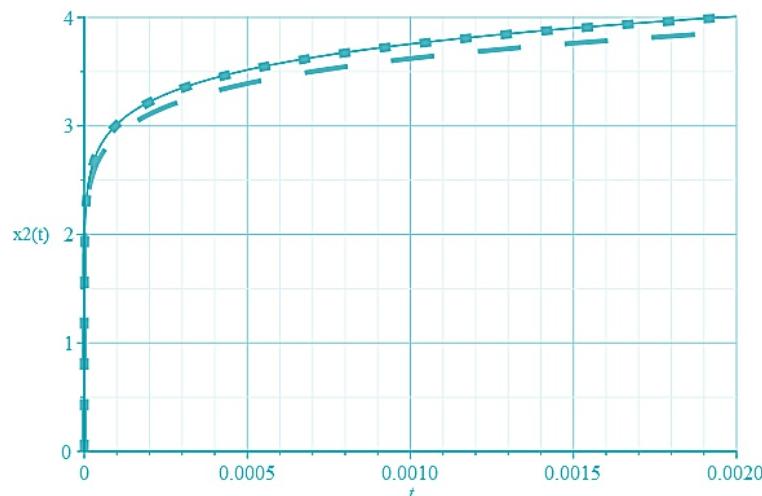


Figure 6. Comparisons between OHAM ($\beta = 0.9$, space dash, $\beta = 1$, dot) and RK4 ($\beta = 1$, solid) at $x_2(t)$ of **example 1**.

Figure 7 shows the domains of convergence of the series solution given by h_1 at $x_1(t)$ and h_2 at $x_2(t)$ of example 2 and provided a clear region of the optimal values for the convergence of the proposed solution method.

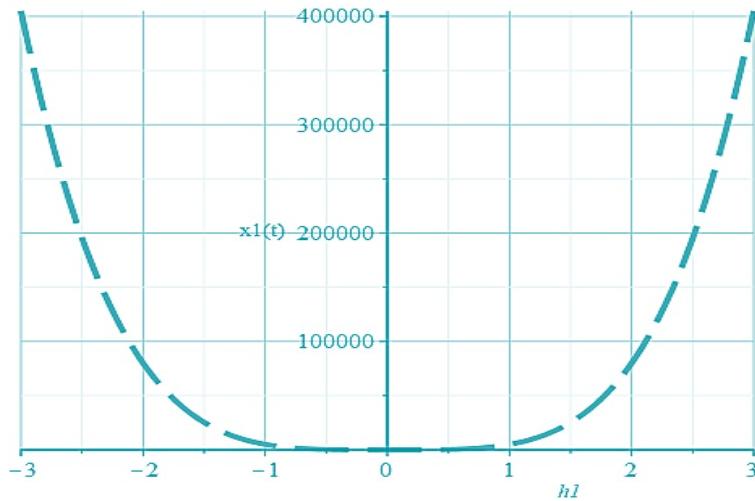


Figure 7. The h_1 -curve of OHAM, for example 2 at ($t=2$) of $x_1(t)$.

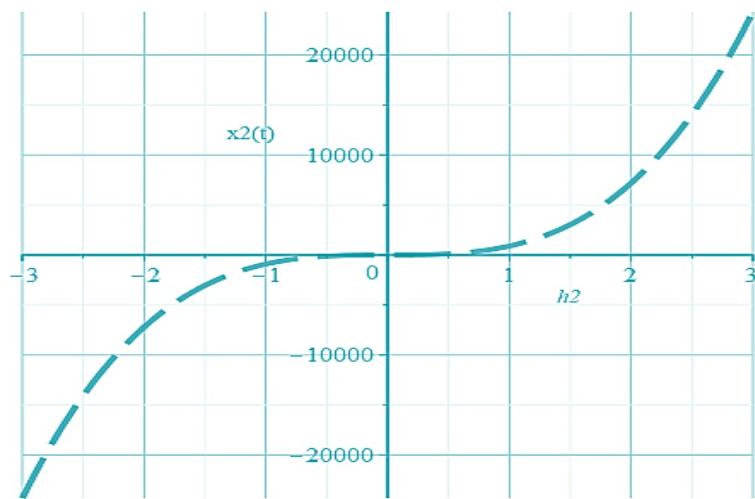


Figure 8. The h_2 -curve of OHAM, for example 2 at ($t=2$) of $x_2(t)$. The h_2 -curve in figure 8 shows the domain of convergence of the series solution of example 2, between an interval of $-1 < h_2 < 1$ at $x_2(t)$.

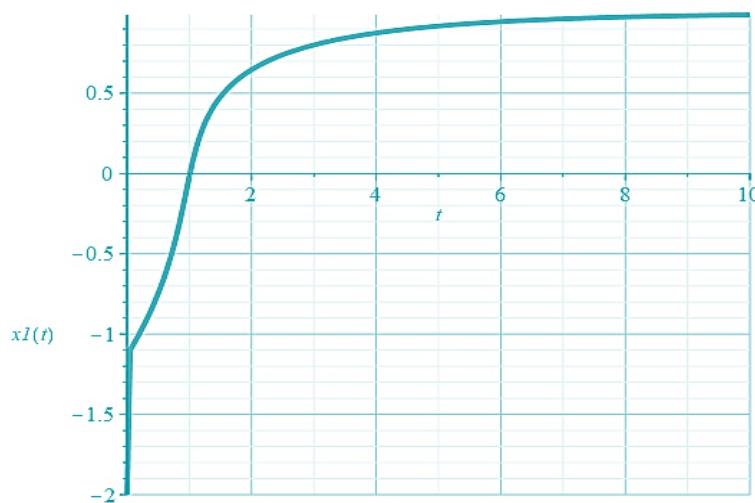


Figure 9. The mathematical simulation of OHAM solution for $\beta=0$.
For example 2 at the third-order approximation of $x_1(t)$.

Figures 9 and 10 show mathematical simulations of the proposed method at $x_1(t)$ and $x_2(t)$ of example 2. The mathematical simulation illustrates OHAM solution as an excellent tool to solve the problem.

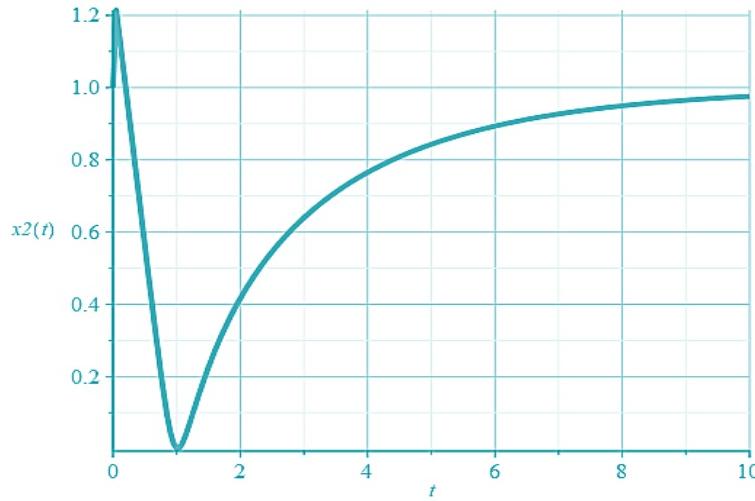


Figure 10. The mathematical simulation of OHAM solution for $\beta=0$.
For example 2 at the third-order approximation of $x_2(t)$.

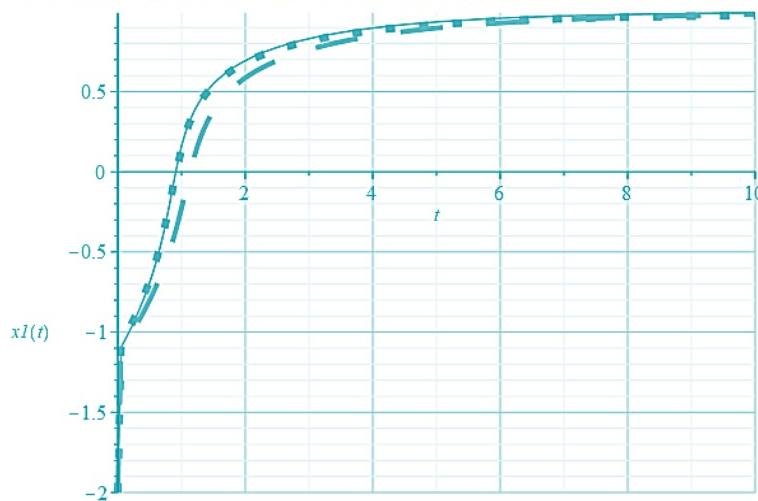


Figure 11. Comparisons between OHAM ($\beta = 0.9$, space dash, $\beta = 1$, dot) and RK4 ($\beta = 1$, solid) at $x_1(t)$ of example 2.

It is seen in Figure 11 that the solution from OHAM is very precise with the expected optimal solution as the values of ($\beta=1$) approaches 1. From Figure 12, the solution from OHAM is very precise with the expected optimal solution as the values of ($\beta=1$) approaches 1

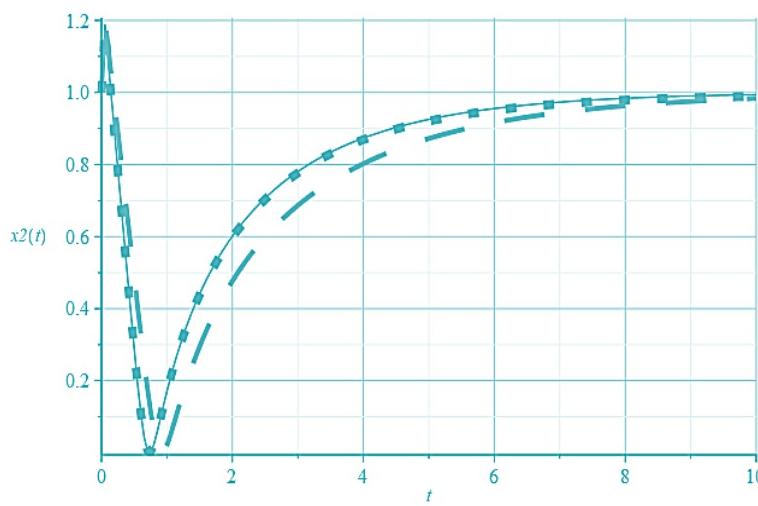


Figure 12. Comparisons between OHAM ($\beta = 0.9$, space dash, $\beta = 1$, dot) and RK4 ($\beta = 1$, solid) at $x_2(t)$ of example 2.

5 Discussion

The results are given by (\hbar_1, \hbar_2) Using OHAM shows the strength of the method on the convergence of the series solution through h-curves plots of the systems for ($\beta=0.9, 1.$) We showed that even three-order terms of the analytical approximation of the solutions are enough to get an accurate solution. It is understandably that the exactness can be optimized by computing a few more terms of the approximate analytical solutions.

6 Conclusion

This paper solved non-linear FOCOP by OHAM after the third order of approximation solution was used with fast convergence and accurate solutions. The numerical comparison among the RK4 and OHAM ($\beta=1$), shows that OHAM would perform fast convergence to the optimal solutions as ($\beta=1$) tends to 1, the integer-order solution for the system is reclaimed OHAM is an effective tool for obtaining an AAS for non-linear FOCOP.

7 Availability of Data and Material

Information can be made available by contacting the corresponding author.

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Okundalaye Oluwaseun Olumide is a Ph.D. candidate in the Institute of Mathematical Sciences (ISM), University of Malaya (UM), Malaysia. He received a bachelor's degree in Pure Mathematics at Adekunle Ajasin University, Akungba-Akoko, Nigeria, and a master's degree in optimization at the University of Unilorin, Ilorin, Nigeria. His research interest is in fractional-order gradient-based dynamic system, fractional optimal control problem, and modeling. He focuses on an approximate analytical method to solve the optimization problem in a fractional calculus sense.



Dr. Wan Ainun obtained is Head of the Centre of Mathematical and Statistical Analysis, University of Malaya. She got her B.Sc. and MSc from the University of Charlotte, North Carolina, and North Carolina State University. She got her Ph.D. in the area of Computer-Aided Geometric Design. Her main research interests are in Cryptography, Geometric Modelling, and Differential Equations.



An Effective Quality Assessment Method for Plasma Welding Based on the Plasma Gas Flow Rates in Titanium Grade 2

Adisak Aumpiem^{1*}, Asa Prateepasen¹

¹ Department of Production Engineering, King Mongkut's University of Technology Thonburi, THAILAND.

*Corresponding Author (Tel: +66-815710-128 Email: Aumpiem@Gmail.com).

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Abstract

Most weld defects are from weld stops and starts. Plasma arc welding (PAW) is a process that it is necessary to repeat welding in the same area (start-stop area) to close a keyhole of pipe welding works in which this area obtain more heating rates than other welded areas. This study proposed a quality assessment in PAW by investigative the changing of plasma gas volume in welding a Titanium Grade 2. Weld studies involve the influent of the plasma gas led effects on “cycle start/stop” and weld zone in terms of ultimate tensile strength, hardness, welding profile, discolorations on surface welded, SEM and EDX. The results of the proposed method show that the plasma gas flow at 4.24-4.28 L/min gives the most positive results in both mechanical properties, welded profile, and discolouration of weld surface, while the hardness of weld metal and heat-affected zone (HAZ) less than the base material. Furthermore, Surface oxidation of weld zones was visual inspection is in according to standard and no negative results at 4.20-4.32 L/min and the heat repeated at the cycle of start/stop area causing coarse grain on the root welded. Such information is very useful so that appropriate welded quality assessment can be applied parameter to develop and achieve in the industry.

Disciplinary: Welding Engineering and Technology.

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1 Introduction

The plasma arc welding (PAW) process brings the highest quality standards for titanium and titanium alloys that have been extensively used in the industry widely in the seawater systems of offshore industries and also at the same time the PAW saves time and costs including the welding

quality ensuring weld and penetration welded [1]. The Titanium Gr.2 has been successfully utilized because it provides high strength, ductility, exceptional biocompatibility, and excellent corrosion resistance [2-3]. PAW produces an inner plasma gas and the outer shielding gas serving the same intention as in GTAW and many critical advantages over TIG welding [4-5]. Shielding gas of the weld pool is provided by the ionized gas by combining charge particles electron, ion, and molecules[6-7]. The energy of the density for PAW is controlled by the plasma gas flow rate and welding current. The keyhole is an important open hole melted through the workpiece which has liquid metal sides and is held open by the power applied by the plasma gas flow. A three-dimensional model was developed to periodic the heating temperature as an effected weld pool and keyhole geometry in the PAW process [8]. These outcomes in an inherently unstable mechanism during the start and stop of the weld cycle [9-10]. In the welded, it is understood throughout the welding industry that most weld defects are attributed to weld stops and starts area. When welds on pipe or curved workpiece are often rotated while the welding torch of PAW machine fixed stationary. In the start and stop area, the keyhole is the most difficult part of the keyhole in PAW when made on rotating workpiece and often welded defect or voids to be created at start and stop area on weldment.

The work aimed to study and demonstrate in welded quality assessment focused on the start and stop welded area by investigates the influence of Plasma gas flow rate affecting welded on Titanium Gr.2, thickness 3.05 mm in butt joint rotation configuration. Firstly, the value of plasma flow rate (A) has been designed to investigate in tensile and hardness tests are evaluate conducting the physical properties. The weld geometry profile, thermal temperature, and discoloration on weld surface determining in terms of welding quality assurance. Finally, SEM and EDX are studied in metallurgical systematical arcs.

2 Theory Background

Nowadays, The growing demand for energy worldwide requires that attention be given to quality and risk management to utilize products. The offshore construction project was concerned with the fabrication welding process may many more factors a delay in any one of those variables that can delay a project in varying degrees. The welding technology or technical knowledge can help mitigate the negative risk and lead the positive risk is also known as an opportunity is the enhance risk response strategy. Titanium alloys have been used widely in offshore structures of seawater systems or heat exchangers, especially in fire water and seawater coolers. Commercially pure titanium Grades 2 is a primary use. The most common method of joining titanium is Plasma welding (PAW) and Gas tungsten arc welding (GTAW) available and are capability practiced to created weld joints[11]. In the welded, it is understood throughout the welding industry that most weld defects are attributed to weld stops and starts area.

2.1 Plasma Theory and Plasma Arc Welding

Welding is a method of joining to applied the heat and/or pressure between the two workpieces. The Plasma arc welding process most high productivity used for titanium alloys. The welding joint of thin thickness at microscale was established called the micro-plasma process [12-13]. The characterization of PAW, the torch has a nozzle that creates a gas chamber encloses the tungsten electrode. The arc heats energy of the gas fed into the orifice chamber to a temperature effect where it transforms into the ionized and conducts electricity. The ionized gas is defined as plasma. Plasma is a gas that is ionized. It is considered a state of matter with an energy value of less than 10 kilo-electron volts (<10 keV). The plasma consists of both positively charged and negatively charged particles. The proportion that makes the total charge zero. These particles are quasi-neutral, which means that the electrons and ions in that area are in equal numbers and exhibit collective behavior. Plasma can be produced by providing an electric field. A large quantity to a neutral gas, when enough energy is passed through free electrons for free electrons to collide with atoms and causing electrons to escape from atoms. This process is called “the process of ionization” which occurs rapidly, dramatically increases the number of ejected electrons that break down the gas and eventually become plasma. Plasma is classified as the fourth state of matter. Plasma differs from the solid, liquid, and gaseous state with three conditions: the wavelength, number of particles, and plasma frequency. This gives the plasma a specificity that is different from the other states. Thus, the plasma arc occurred is one of the major factors when ascertaining the influence of arc plasma on the weld pool [14].

2.2 Titanium Materials

Titanium Grade 2 is a commercial pure grade with 99% minimum titanium. Commercial-grade titanium is divided into grades 1, 2, 3, and 4, in which each grade has a slight difference in chemical composition, mechanical properties, whereas corrosion resistance is similar across all four grades. Titanium is lightweight at just half the weight of steel and the ultimate tensile strength similar to mild steel [15-17]. Titanium Gr.2 is good very corrosion resistant has been used in seawater systems such as firewater systems of an offshore platform. The most common method of joining titanium is plasma welding arc applied for specific applications. The atomic weight of titanium is 47.88. Titanium is lightweight and strong. Titanium and its alloys possess tensile strengths from 210-1380 MPa. The continuous service temperature of Titanium Gr.2 can reach up to 800°F with occasional, intermittent service at 1000°F. The pure titanium structure is a major of titanium alloys, the crystal structure at low temperature is a hexagonal close-packed(hcp) structure, called α -titanium and at high temperature is body-centered cubic(bcc) structure is stable and is referred to as β -titanium. The two different crystal structures and transformation of the temperature effected of heating is a significant basis of achieved in the properties of titanium alloys. During welding, the weld pool zone is heated to 882°C or above, developing in the transformation to the β phase. As welding cool down through the β transits, the cooling rate from the β phase field has a controlling influence on the resulting microstructure in a CP-Ti.

3 Experiments procedure

The objective of the study was set up that welding parameters are volt, ampere, arc length, and wire-speed while the plasma gas flow rate arc affects the Start/Stop area investigated respectively shown in Table 3. Before welding, Titanium specimens were cleaned from oxides and contamination on the surface by acetone.

3.1 Material and Welding Procedure

The base material used in this study was Titanium pipe, ASTM B861 Grade 2 were cut to the required dimensions of OD 88.9 mm, circumference 558 mm, thickness 3.05 mm, and length 150 mm as by abrasive cutting to prepare the joint configurations, shown in Figure 1. The welding consumable ERTi-1 for Plasma welding (PAW) was supplied by Oxfords alloy, diameter 1.2 mm.

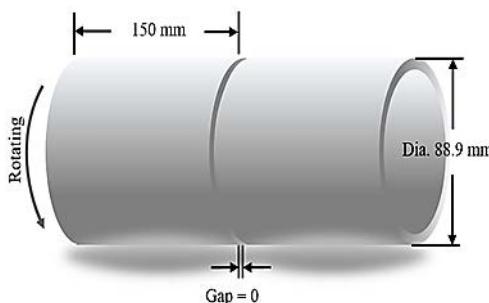


Figure 1: Joint configuration for Plasma welding

The welding consumable with the normal composition of C 0.03%, O 0.10%, H 0.008%, N 0.020%, Iron 0.20% and remainder balance Ti. The welding consumable classification of ERTi-2 with a diameter of 1.0 mm was chosen as the filler material. The chemical composition and physical properties are given in Tables 1 and 2 respectively. The micro construction of thickness section Titanium Gr.2 is shown in Figure 2.

Table 1: Chemical composition of the pure Ti pipe and filler metal (wt.%)

Composition (wt %)	Ti	Fe	C	N	H	O
Base metal	Balance	0.02	< 0.01	< 0.01	0.006	0.07
Filler metal	Balance	0.048	0.010	0.007	0.002	0.098

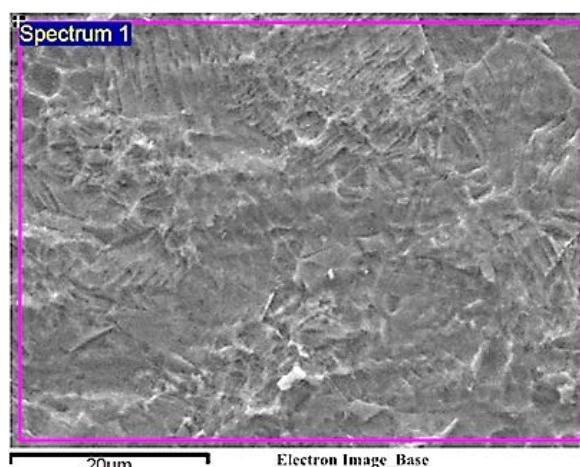


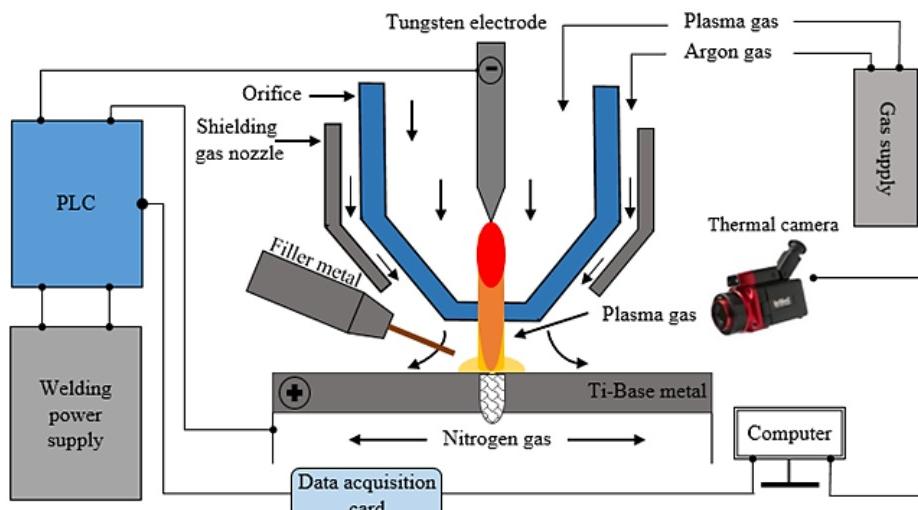
Figure 2: SEM image of base metal - Ti Gr.2

Table 2: Physical properties of Titanium Gr.2.

Material	Tensile strength, Rm, (MPa)	Yield strength, Rp 0.2, (MPa)	Elongation, A5, (%)	HRB
Base metal	436	296	37.5	84
Filler metal	345	275	20	n/a

3.2 Plasma Welding Procedure

The plasma system mainly consisted of process control, plasma controller, wire feeder, and needed accessories. The data acquisition system mainly consisted of a PC base database and a thermal camera. During the welding process the welding current, voltage, plasma gas flow into PTW300 welding gun 300 amps (duty cycle 100%) and high precision wire feeder W21 were controlled by the process control system by ESAB Aristo 5000, 500A (60% intermittence) and analog valve controlled by PLC of Plasma controller W304. The plasma arc was recorded and imaged by a Thermal camera (InfReC R550 Pro), which was set to focus on the fixed region around the nozzle of the unmovable plasma arc torch. The experimental data were displayed and recorded by a PC base database computer. The principle of the plasma welding machine in the pipe is shown in Figure 3.

**Figure 3:** Schematic diagram of the experimental plasma welding system

Before welding the test specimens were ground using carbide burrs grinding size D12x25 and cleaned with acetone for at least 30 mm on each side of the weld line area. The welding parameters resulting in the keyhole of star/stop points were arrived by trial resulting in visual good welds. The welding parameter and influence of plasma flow rate change as shown in Table 3.

Table 3: PAW process parameter used in this investigation

Specimens (No.)	Current (A)	Volte (V)	Arc length (mm)	Wire-speed (Cm/min)	Plasma gas flow (L/min)	Plasma gas flow rate (%)	Tungsten setback (mm)
#1	145	23.75	8	85	4.20	-	4
#2	145	23.75	8	85	4.24	1%	4
#3	145	23.75	8	85	4.28	2%	4
#4	145	23.75	8	85	4.32	3%	4
#5	145	23.75	8	85	4.37	4%	4
#6	145	23.75	8	85	4.62	10%	4
#7	145	23.75	8	85	4.83	15%	4
#8	145	23.75	8	85	5.46	30%	4

Depicts the schematic illustration of PAW. In PAW, the molten flow by arc near the keyhole is transported backward through both sides of the keyhole and therefore produces a weld pool as shown in Figure 4(a). It is required to fill the void behind the keyhole with the molten flow for maintaining welding stability. There are two necessary conditions for welding stability: the molten flow on both sides must bridge the gap formed at the rare part by the passage of the keyhole and also, the molten flow is supported by the surface tension action on the back surface weld pool surface.

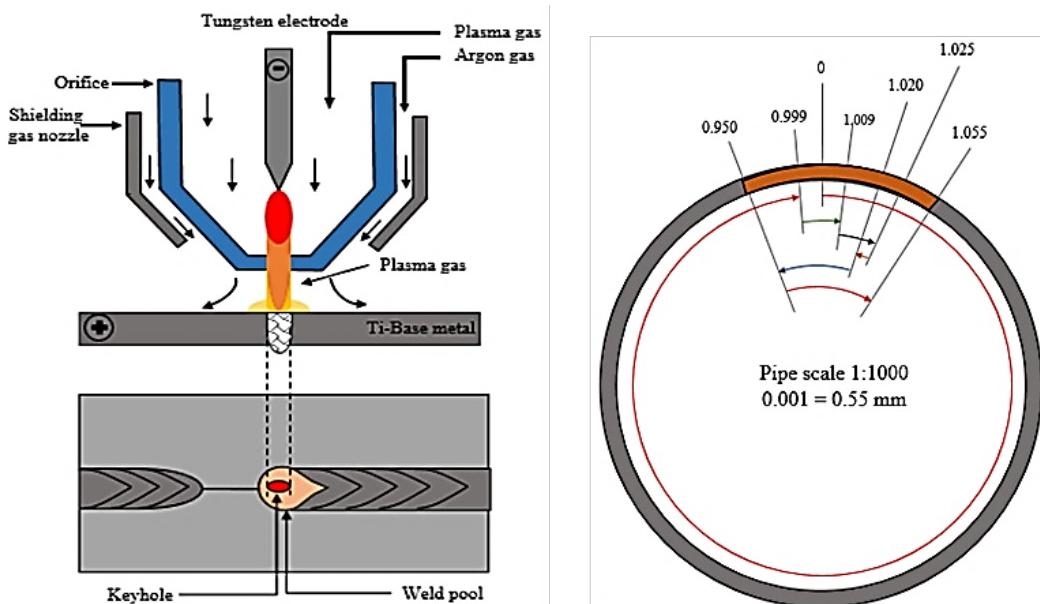


Figure 4: (a) Schematic illustration of the PAW process, (b) Cycle rotating as start/stop welded area

The welding torch over a workpiece can be rotated at a fixed speed. The workpiece is rotating and at approximately the same rotational speed and the relative of moving between the PAW torch and the workpiece is Zero until the PAW torch current and plasma temperature are at full operating levels. The welding rotation steps by each pass (root and filling passes) setup from Figure 4(b) start at sector 1 is from zero to 0.999 when the sector 2 is starting, Sector 2 starts at 0.999 and are active to 1.009 when sector 3 starts, Sector 3 starts at 1.009 and are active to 1.025 when sector 4 starts, Sector 4 starts at 1.025 and go backward to 1.020 when sector 5 starts, Sector 5 starts at 1.020 and go backward to 0.950 when sector 6 starts, Sector 6 starts at 0.950 and are active to 1.055 when sector 7 starts, Sector 7 is the stop sector, the plasma welding machine stop at 1.055 respectively. The welding pass was online monitored the temperature during welding by a Thermal camera.

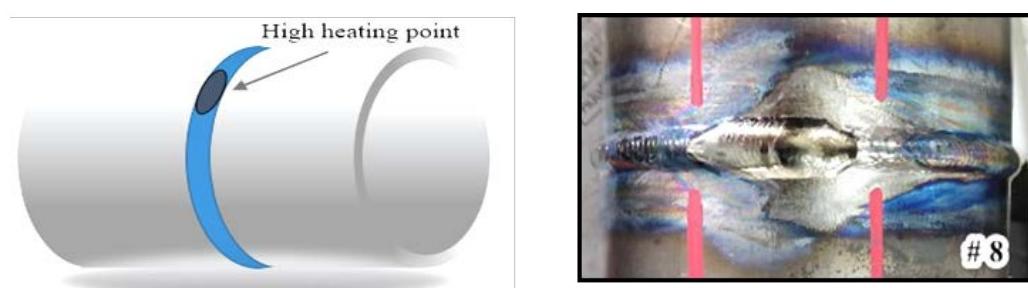


Figure 5: (a) PAW welding completed, (b) Start and stop welded of study.

After weld completed in Figure 5, The radiography test (X-ray) was confirmed the quality of weldment on the double heating area (high heating point) after welding completed. The X-ray power source 80 KV, 5mA, Source size 3.0 mm, Density 2.8-3.1, Sensitivity wire no.5, Intensifying lead screen thickness 0.027 mm, and Film Agfa D5 was applied used to confirmed weld.

4 Results

All welded specimens were cut and preparing on the double heating area of the PAW. The objective for review and identify the main course of weld poor quality which leads to the effect of quality, cost, and time.

4.1 Effect of Plasma Flow Rate on the Tensile Properties

According to the below analyses. The tensile strength of the welded specimens at different plasma gas flow rate was observed at the start/stop area is depicted in Figure 5. It can be concluded that the tensile strength of the welded joint. The average 0.2% offset yield stress and ultimate tensile strength of actual base materials were YS=465 MPa. and TS=552 MPa. The experimental resulted found that specimen#7 is the highest yield stress of were 373 MPa. The trend of high ultimate tensile strength starts from the plasma flow rate as 4.37 to 4.83 L/min and drops as a flow rate of 5.46 L/min. The specimen#5 is the highest ultimate tensile strength were 465 MPa. The stress-strain curves of all specimens shown in Figure 6 were quite different and the highest plasma flow rate not always to the higher tensile strain of the joints and observed found that the tensile strength resulted all shown that the ultimate tensile strength value is lower than the base material. The lowest percent ultimate tensile strength (31.8 %) value is seen for the specimen welded no.4 at plasma flow rate 4.32L/min when a comparison of the base material.

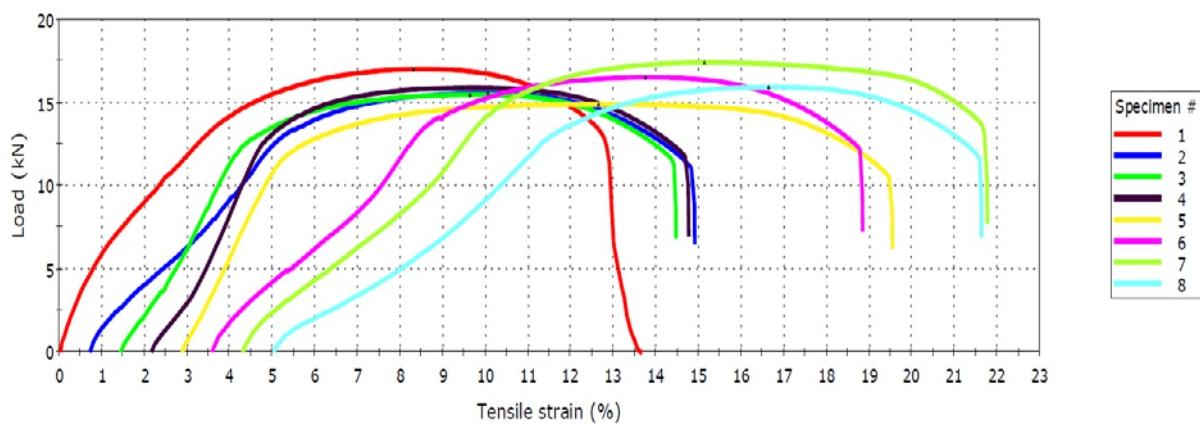


Figure 6: Tensile stress-strain curves for PAW welded in Titanium Gr.2

4.2 Thermal Temperature and Hardness Test

The plasma flow rate is effective to hardness, The micro-hardness across the weld centerline, HAZ, and the base metal result is shown in Figure 7. It can be seen that the average hardness resulted were obtained for the weld metal region is 137.56 HV and HAZ is 120.32 HV. Furthermore, The average of base material obtained is high than weld metal (155.4–146.2 HV) and HAZ region(110.2–143.4). It is clearly seen that the plasma gas flow rate to increase, the hardness affected into weld metal and HAZ region is reduced. Hardness value resulted in to increase as the plasma gas flow rate average is 4.37 to 4.83 L/min. Moreover, experimental results showed a

hardness value on weld metal and HAZ less than the base material. Hardness is found to be very high in weld metal 146.2 HV as a flow rate of 4.37 L/min. while the highest hardness value on HAZ = 143.4 HV as flow rate 4.32 L/min.

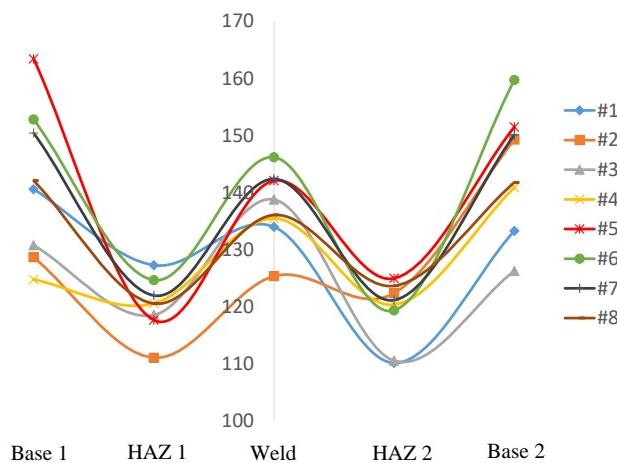


Figure 7 Schematic diagram shows the micro-hardness test along the section of welded(HV)

Thermal camera(InfReC R550 Pro) is infrared detector type Micro-bolometer, the capability for heating measuring rang up to 2000°C and accuracy ± 1 °C at the room temperature 20-30°C, the resolution pixels is 640x480 pixels. The original arc image Figure 8(a) shows before effective with plasma gas. The highest temperature of the plasma flow rate at 5.46 L/min is shown in Figure 8(b). The heating temperature of plasma arc of #8 is the highest temperature, point C is 1935.7°C, A=107°C, B=226°C, D=411 °C, and E = 157°C respectively.



Figure 8: (a) Initial arc image; (b) Heating temperature of plasma arc

4.3 Welding Profile

The reinforcement is a factor in risk problems in welding quality controls. The higher weld reinforcement has a shorter fatigue life [15] and unacceptable such as in welding inspection standard, NORSOK M-601 is one standard were specified the acceptance criteria for visual testing the reinforcement or internal protrusion for pipe wall thickness ≤ 6 mm is 1.5 mm [18]. The welding profile results show in Figure 9, the welding profile of each plasma flow rate is different thickness which the welding profile appropriate 4.24-4.28 L/min and 4.62-4.83 L/min are suitable and comply

with standard reference. Specimens#5 in Figure10. shown the highest of welding profile both Cap welded =3.22mm and root penetration welded = 0.89mm.

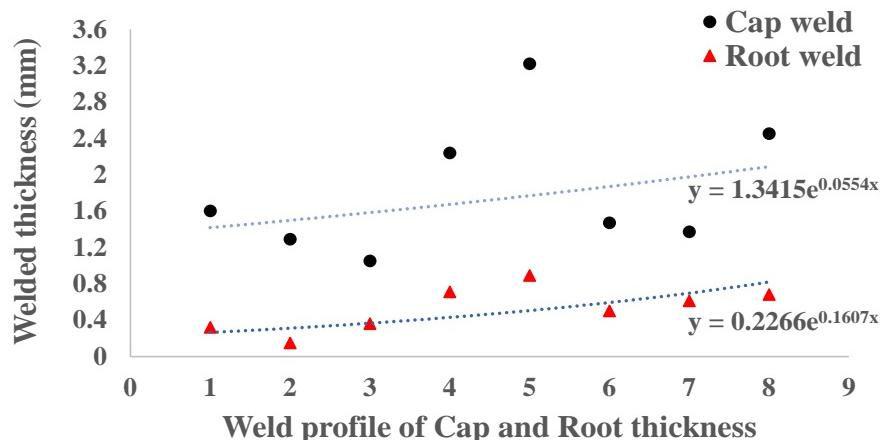


Figure 9: The welding profile of cap and root welded.

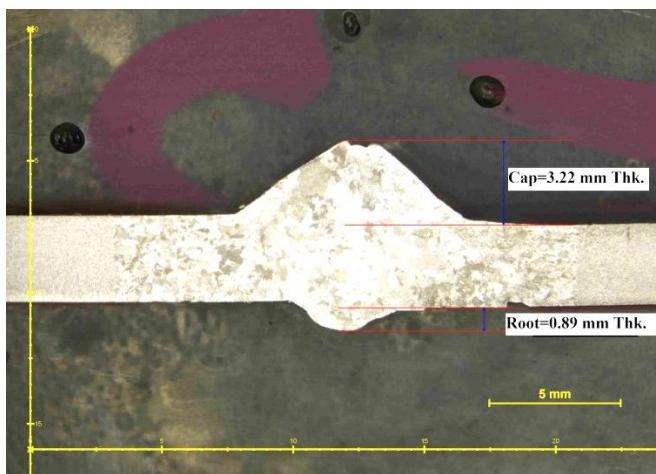


Figure 10: Welded geometric measurement of welded specimens

4.4 Determining Discoloration on the Weld Surface

In the PAW process a low level of oxygen before, during, and after welding is necessary, to achieve minimum oxygen to assess the effects of surface oxidation(discoloration). The welded color was shown the relationship of plasma gas flow rate on finish welded surface and poor indicator some surface contamination occurred during solid-state cooling at high temperature. At a temperature below 500°C a stable oxide layer of metal that provides excellent corrosion resistance. However, the oxidation resistance decreases at temperatures above 500°C, and metal becomes susceptible to embrittlement by oxygen, nitrogen, and hydrogen [19-20]. It is necessary to avoid risk when welding in a material sensitive to oxygen like Titanium or Super duplex. Due to the welding quality assurance in the piping system to determine whether the weld is of suitable quality. The color that occurred from the plasma flow rate which relates to the heating was determination and the acceptance criteria is a major point to be subject on the welded surface. The NORSOCK M-601 standard was evaluated and give the accepted color on the weld metal surface: silver and straw. A narrow band of intensive color close to the limits of the gas shielding is acceptable. Darker brown, purple and blue color and grey or flaky white are not acceptable. The welding experimental resulted found that the risk range of plasma gas flow complies with NORSOCK standard and

acceptable are specimens no.#1-#4 while specimens no.#5-#8 are unacceptable and need improvement in the project shown in Figure11.

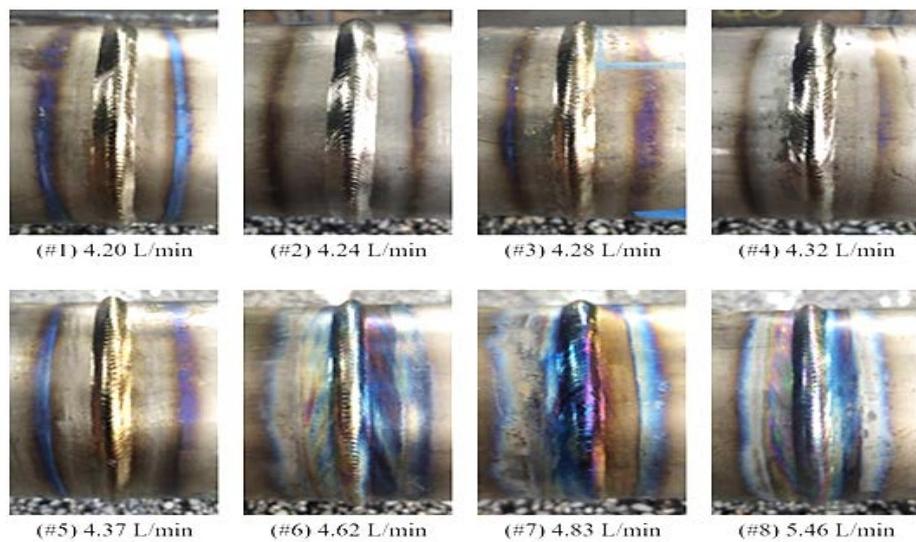


Figure 11: Effective of Plasma gas flow rate relate to coloration

4.5 SEM and EDX

The scanning electron microscope (SEM) scan a focused uses high-energy of electrons beam to generate a variety of surface specimens to create an image[19]. Energy Dispersive X-Ray Analysis (EDX) is an analytical technique used for the chemical composition of sample specimens. It relies on the interaction of some source of X-ray excitation and a sample. EDX spectroscopy confirmed that the alloy is Ti Gr.2 also known as commercially pure(CP) titanium alloy shown in Figure 12.

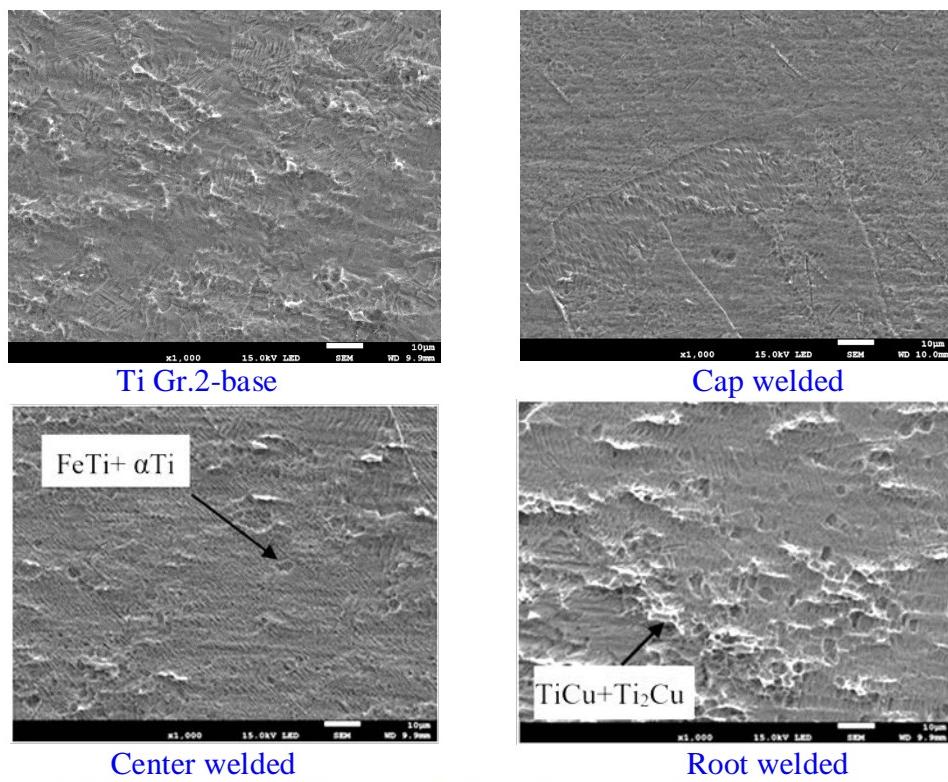


Figure 12: SEM images of Base metal, Cap, Center, and Root welded respectively

To examine the cap and root surfaces weldment of Titanium Gr.2. The fracture surfaces were investigated with SEM to determine the fracture mode. The arrows point figure shown to high-temperature beta phase boundaries (substructure in alpha cells). As the high temperature affects the mechanical properties and metallurgy of materials.

It can also be concluded that oxygen is present in the weld region which is consistent with the formation of TiO₂ during the plasma welding. The oxygen concentration is found to increase from 2% to 6% in the welded region with respect to the base material. The microstructure consists of fine equiaxed alpha grains and EDS showed that carbon content in the Titanium promoted improvement of the grain boundaries and characteristic of twin grain[22-24].

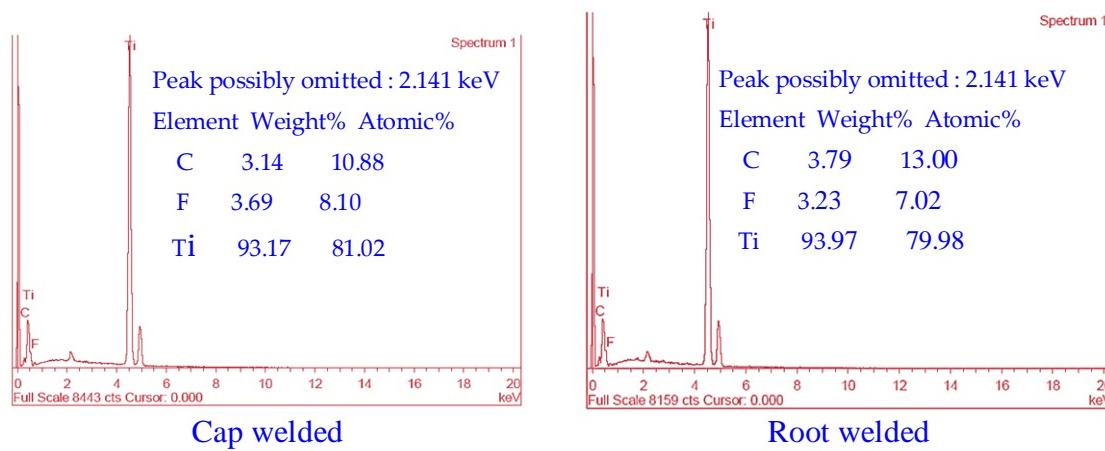


Figure 13: EDX results in the cap and root welded.

5 Discussion

These results can be recognized as acceptable industrially as the strength calculations made in the design of a fabricated structure are based on the properties of the metal being used. Titanium alloy Gr.2 were joined successfully by the plasma arc welding method at various welding plasma flow rates using on cycle start/stop welded. The effect of changing the plasma flow rate in experimental in term of welding quality is the following:

The physical properties, the start/stop welded joint strength was found to be at least as much as that of the base metal when suitable welding current was used. The highest average of tensile strength 404.8 MPa. and the ultimate tensile load 16.06 kN. The tensile strength variance was in the range of 376.0-435.4 MPa. The hardness values of the weld metal and HAZ were lower than that of the base metal. Increasing plasma gas flow rate reduced the hardness of weld metal and HAZ. The hardness samples continuously on weldment ranged from 125.4 to 146.2 HV. Welding quality for the plasma gas flow rate in Titanium Gr.2 increased, physical properties both tensile and hardness 4.37-4.83 L/min, and while continues increased both the tensile and hardness to be reduced.

Welding quality assurance to assure in quality of welds. The value of plasma gas flow increases the thermal temperature of weldment and reduced the hardness of HAZ and welded. Quality of weld, weld profile on the start/stop area highest reinforcement as 3.22 mm. The increase of plasma gas flow is the main factor affected discolouration on surface welded and reduced corrosion properties in materials. Experimental results found that flow rate at 4.20-4.37 L/min (#1-

#5) is allowed to match acceptable discoloration levels for weld and heat-affected zones while all above is unacceptable base on the standard of welding quality assurance.

Finally, Acicular alpha and twins with different sizes dominated all of the weld metal microstructures, as investigated and shown in Figure 10. The two-zone of the welded on start/stop area is now clear that the two zones in the welded joint have different microstructures due to the temperature variations during welding and cooling processes. The coarse grain observed on the root welded occurs in heat repeated as the same position of welding. The microstructure of welded depending plasma flow rate effected by acicular alpha, coarse-grained serrated alpha, and twins. The twins are the distinct microstructure found in weldment especially near the weld root. The EDX characterizations found that α Ti + FeTi was displaced from the α Ti + Ti₂Cu phase at the highest confirmed that carbon content as the root part is increased the grain boundaries becomes improved.

6 Conclusion

This study lays the foundations for comparisons in welding quality for PAW in the effect of plasma gas flow rate on the start/stop welding by consideration in term of physical properties, quality assurance and metallurgical are following:

1. Plasma flow rate as 4.32 L/min(specimens#4) gives the lowest yields and tensile strength volumes and lower than the actual tensile strength of base material 31.8%
2. All of the Plasma flow rate range, the hardness test on welded higher than HAZ but less than the base metal. Several noteworthy results were 4.28 L/min, the hardness of base metal less than a welded(specimens#3)
3. Welding profile consideration as cap and root welded, the all suitable welding profile except the flow rate 4.37 L/min. (specimens#5)
4. Welding quality inspection for coloration on surface welded according to NORSOK standard, unacceptable were 4.62-5.46 L/min (specimens#6-8).
5. SEM and EDX confirmed that the coarse grain occurs in the region of heat repeated in the start/stop welded area and the chemical composition to help improve the ability of weldment.

The contribution of this study establishes the opportunities competitive, reduces cost and time. Moreover very useful so that appropriate welded quality assessment can be applied parameter to develop and achievement in the industry.

7 Availability of Data and Material

Information can be made available by contacting the corresponding author.

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Professor Dr. Asa Prateepasen is Professor of the Department of Production Engineering at the King Mongkut's University of Technology Thonburi. He received his B.Eng. and an M.Eng. from the King Mongkut's University of Technology Thonburi and B.E. Ramkhamhaeng University. He got a PhD in System Engineering from Brunel University, United Kingdom. Prof. Asa's interests involve Applications of Acoustic Emission and Non-destructive Testing, Management of Project e.g. Risk Management, Quality Management.



Adisak Aumpiem received a Bachelor of Engineering (B.Eng.) degree in Welding Technology from the Mongkut's University of Technology North Bangkok (KMUTNB) and an M.Eng. degree in Welding Engineering from King Mongkut's University of Technology Thonburi (KMUTT), Thailand. He worked in the welding & NDE industry and currently is the welding coordinator in an offshore construction company. His research interests include Welding Quality Systems/Controls, Risk Management in Project.



C-UPFC Modeling in NEPLAN for Power Flow Analysis

Ayman Awad ¹, Salah Kamel ¹, Ali S. Alghamdi ^{2*}, Francisco Jurado ³, Mohamed Zohdy ⁴

¹ Department of Electrical Engineering, Aswan University, Aswan 81542, EGYPT.

² Department of Electrical Engineering, Faculty of College of Engineering, Majmaah University, Majmaah 11952, SAUDI ARABIA.

³ Department of Electrical Engineering, University of Jaén, 23700 EPS Linares Jaén, SPAIN.

⁴ Electrical and Computer Engineering Department, School of Engineering and Computer Science, Oakland University, Rochester, MI 48309, USA.

*Corresponding Author (Tel: +966(16)404-2568 Email: AAlghamdi@mu.edu.sa).

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C-UPFC modeling;

Power flow.

Abstract

Center node Unified Power Flow Controller (C-UPFC) is considered as the most recent FACTS device. When attached to the desired transmission line, typically at the midpoint, it influences the flow of active and reactive power through the transmission line, even from its sending and receiving terminals, besides controlling the voltage level of the midpoint that the device is connected. This paper introduces a model for C-UPFC in NEPLAN software, aimed to be utilized for power flow analyses incorporating this device in power systems. It is designed using the components available on the utilized software so that it can be integrated with case studies tests and analyses performed by such software. The power injection method is used in designing the model to facilitate the calculations for analyses involving the device. A test is carried out to this model on IEEE 30 bus and IEEE 14 bus power systems to guarantee its quality in different cases for each system.

Disciplinary: Electrical Engineering and Technology.

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Nomenclature

C-UPFC

Center-node Unified Power Flow Controller

FACTS

Flexible AC Transmission systems

IPFC

Interline Power Flow Controller

p.u.	Per Unit
P	Active power
Q	Reactive power
S	Apparent power
SSSC	Static Synchronous Series Compensator
STATCOM	Static Synchronous Compensator
TL	Transmission Line
UPFC	Unified Power Flow Controller
VSC	Voltage Source Converter
V_R	Receiving voltage source
V_S	Sending voltage source
V_{Sh}	Shunt voltage source
X_R	Impedance of Receiving voltage source
X_S	Impedance of Sending voltage source
X_{Sh}	Impedance of Shunt voltage source

1 Introduction

Flexible AC Transmission Systems (FACTS) is a well-known technology that is utilized in the few last decades to control a transmission line and improve its stability, transferability, and performance improvement of a power system in general. With the advance of power electronics through the last years, DC-links with VSCs enabled the utilization of DC storage in FACTS devices, replacing passive components used before, like capacitors and reactors [1]. Hence, FACTS technology achieved development, resulting in a variety of advanced FACTS devices with superior capabilities, including STATCOM, SSSC, IPFC, and UPFC varieties [1-5]. One of the most recent and spectacular FACTS device developed is C-UPFC. It is said to be one of the most powerful FACTS devices. It is mounted to the middle, typically the transmission line midpoint, and hence, it has the capability of controlling the flow of active and reactive energy from end-to-end of the line, and the voltage level of the midpoint as well [11, 12].

The modeling of such devices in different simulation software is attracting the intention of many. In [6] and [7], the STATCOM model is presented using MATLAB software involving the Newton-Raphson load flow algorithm. While in [8] and [9], the SSSC model is presented, wherein [9], SSSC modeling was presented in MATLAB software, while in [9] it is implemented using NEPLAN software. The work [10] presents a model of IPFC using MATLAB regarding the Newton-Raphson algorithm for load flow.

For involving C-UPFC regarding power system analysis, few contributions were presented. In [11], a C-UPFC model is proposed with a control design for performance enhancement of C-UPFC regarding power transmission applications. In [12], another C-UPFC model is proposed using only one voltage source converter instead of three voltage source converters, where this model is implemented by PSCAD software for transient analyses. In [13], a C-UPFC model is proposed for performance improvement of induction-based wind farms, where this model is implemented using

MATLAB Simulink software. In [14] and [15], modeling of C-UPFC is introduced by MATLAB software involving the Newton-Raphson algorithm for load flow.

This paper introduces a C-UPFC model for power flow analysis, where it is implemented by NEPLAN software. Injection of active and reactive power to a system is the dependable technique for such a model, and it is established by NEPLAN software existed components. This model can help to calculate the desired analyses incorporating C-UPFC in power systems. It was assessed on IEEE 14 bus and IEEE 30 bus power systems in different test conditions, where the control values and location of installation are varied so that the robustness of such a model is ensured.

2 C-UPFC Structure

Due to the importance of power flow regulation and voltage control, UPFC was innovated. However, it has a drawback, that it can regulate power flow from one side of the transmission line only i.e. even the sending terminal or the receiving terminal. Figure 1 shows the schematic diagram of the UPFC.

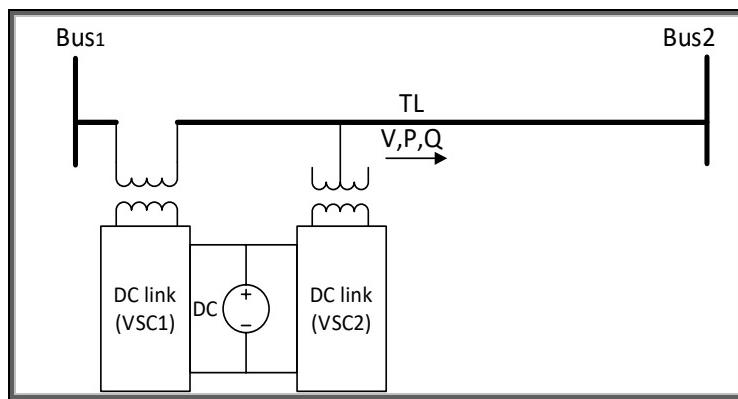


Figure 1: Schematic diagram of UPFC

For overriding such a drawback, C-UPFC was innovated by Olorunfemi Ojo and Sanbao Zheng [6]. It is mainly designed to be installed at the desired TL midpoint. It consists of a DC source, three DC-links, three coupling transformers, where these transformers are two series transformers and a shunt transformer. The series transformers are responsible for controlling the flow of active and reactive power from-end-to-end of the TL, while the shunt transformer – connected to the center node of the TL – responsible for voltage regulation. The schematic diagram shown in Figure 2 shows the structure and connection of C-UPFC.

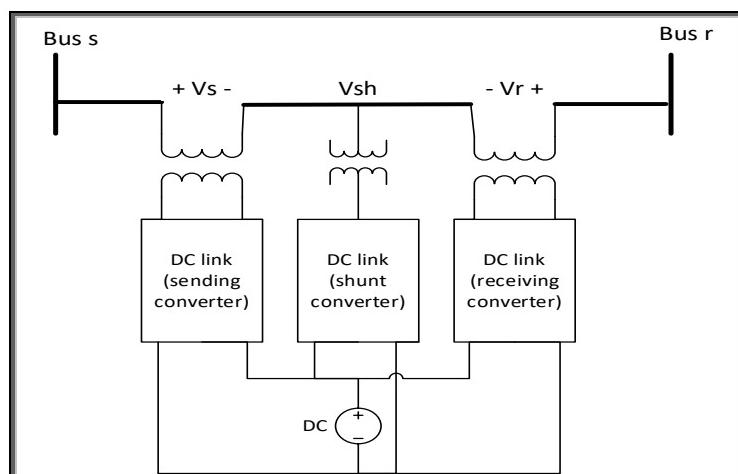


Figure 2: Schematic diagram of C-UPFC

This connection offers exceptional capabilities for C-UPFC. Power transfer maximization can be gained while controlling active and reactive power flow in both sending and receiving ends, besides voltage regulation of the line through the center node. Such a device can be modeled as follows: each DC-link and coupling transformer can be represented as an injected voltage source and an impedance, where two of them are series-connected to the transmission line, while all of them are shunt-connected to the center node, where 3 auxiliary buses are inserted, as shown in Figure 3.

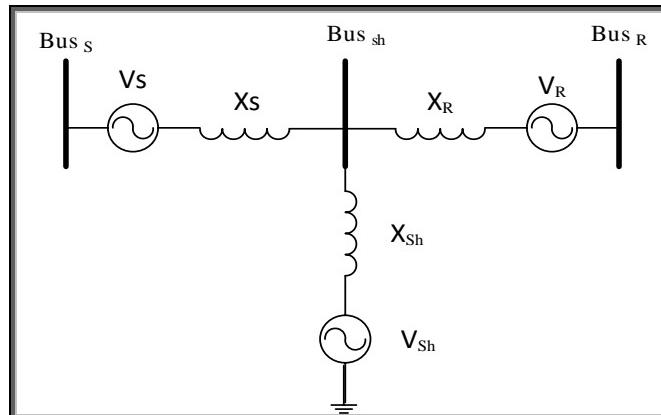


Figure 3: Equivalent circuit of C-UPFC.

Through the injected voltage by sources V_s and V_R , the power flow control is carried out, while the voltage of the center node is controlled by the injected current of V_{sh} .

3 C-UPFC modeling

Due to Figures 2 and 3, the representation of C-UPFC in a TL would result in “dividing” the transmission line into two equal sections, where C-UPFC is inserted between these two sections. The model contains three auxiliary buses: two for the sending and receiving series DC links, and one for the shunt DC link, as shown in Figure 4.

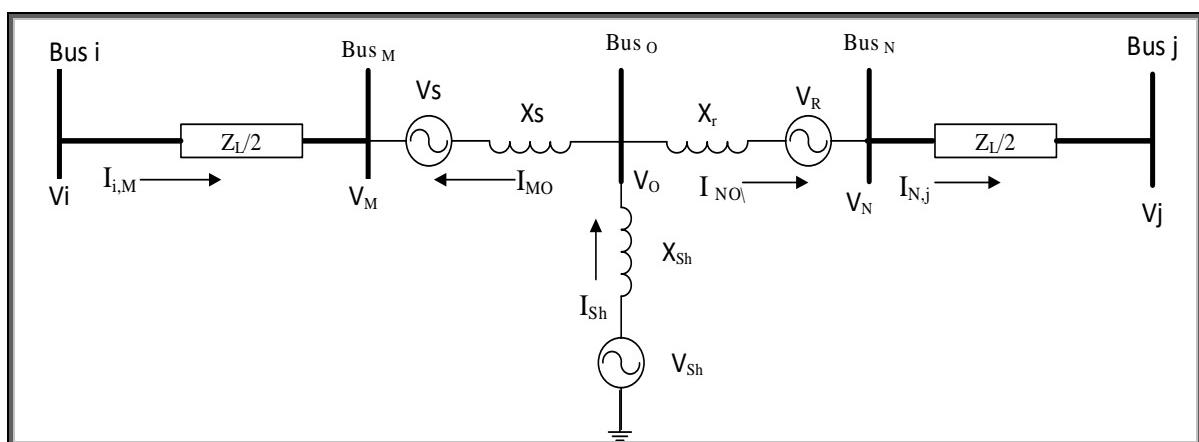


Figure 4: Modeling of C-UPFC

Applying Kirchhoff's current law on sending bus (Bus_s):

$$I_s = I_{MO} - I_{i,M} = \left(\frac{V_M - V_O}{jX_S} \right) - \left(\frac{S_{i,M}}{V_M} \right)^* \quad (1)$$

where I_s is total current sent from bus i to bus M , I_{MO} is the current injected to the line i_M by the sending DC link, $I_{i,M}$ is the current of line i_M , $S_{i,M}$ is power flow through line i_M , and

$$S_{i,M} = P_{i,M} + Q_{i,M} \quad (2).$$

Applying Kirchhoff's current law on sending bus (Bus_r)

$$I_R = I_{NO} - I_{N,j} = \left(\frac{S_{N,j}}{V_N}\right)^* + \left(\frac{V_N - V_O}{jX_r}\right) \quad (3),$$

where I_R is total current sent from bus N to bus j , I_{NO} is the current injected to the line N_j by the receiving DC link, $I_{N,j}$ is the current of line N_j , $S_{N,j}$ is power flow through line N,j , and:

$$S_{N,j} = P_{N,j} + Q_{N,j} \quad (4).$$

Applying Kirchhoff's current law on the center node (Bus₀), then

$$I_{Sh} = I_{MO} + I_{NO} \quad (5)$$

and

$$V_{Sh} = I_{Sh} * jX_{Sh} \quad (6).$$

Due to the illustrated equations above, the model can fulfill the duties of the C-UPFC device i.e. flow controlling of active and reactive power over the line, and voltage level controlling of the center node.

4 Model simulation and testing

This model is put on tests in both IEEE 14 bus and IEEE 30 bus standard power systems, two cases each, where the model is installed in a different position for each case with different control settings.

4.1 Testing in IEEE 14 Bus Power System

This system consists of 14 buses, 20 transmission lines, 5 generators, and 11 loads [16]. C-UPFC model is tested in that system in two cases as follows:

- Case (1): Controlling line 4 (connecting buses 2 and 4) with settings of active power $P= 50$ MW, reactive power $Q= 25$ MVAr, and center node voltage $V_{Sh}=1.0145$ p.u.
- Case (2): Controlling line 5 (connecting buses 2 and 5) with settings of active power $P= 40$ MW, reactive power $Q= 25$ MVAr, and center node voltage $V_{Sh}=1.0435$ p.u.

Figure 5 shows the integration of C-UPFC in NEPLAN software on the system, and Table 1 presents the results of voltage control, while Table 2 presents the results of power flow control on each TL in each case.

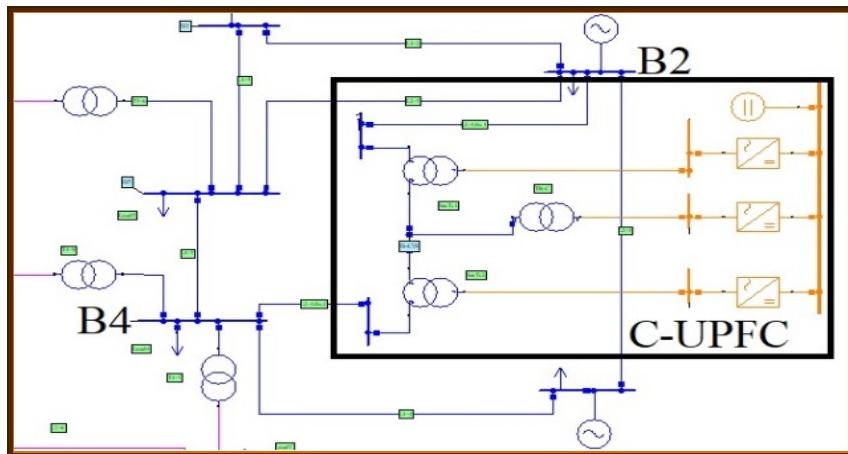


Figure 5: Implemented C-UPFC model integration on IEEE 14 bus power system

Table 1: Results of voltage control of the IEEE 14 bus power system

Bus no.	Base case V(p.u.)∠θ°	Case (1) V(p.u.)∠θ°	Case (2) V(p.u.)∠θ°
1	1.06 ∠0.0°	1.06 ∠0.0°	1.06 ∠0.0°
2	1.045 ∠-5°	1.045 ∠-4.8°	1.045 ∠-4.9°
3	1.01 ∠-12.8°	1.01 ∠-12.8°	1.01 ∠-12.7°
4	1.012 ∠-10.2°	1.0223 ∠-10.7°	1.0172 ∠-10.3°
5	1.016 ∠-8.7°	1.0213 ∠-9.0°	1.0259 ∠-8.9°
6	1.07 ∠-14.4°	1.07 ∠-14.7°	1.07 ∠-14.5°
7	1.048 ∠-13.2°	1.0539 ∠-13.6°	1.0517 ∠-13.3°
8	1.09 ∠-13.2°	1.09 ∠-13.6°	1.09 ∠-13.3°
9	1.032 ∠-14.8°	1.037 ∠-15.2°	1.035 ∠-14.9°
10	1.031 ∠-15°	1.0353 ∠-15.4°	1.0337 ∠-15.1°
11	1.047 ∠-14.8°	1.0489 ∠-15.1°	1.0481 ∠-14.9°
12	1.053 ∠-15.3°	1.0538 ∠-15.5°	1.0536 ∠-15.3°
13	1.047 ∠-15.3°	1.0476 ∠-15.6°	1.0473 ∠-15.4°
14	1.02 ∠-16.1°	1.0234 ∠-16.4°	1.0222 ∠-16.1°
V _{CP}	-	1.0145 ∠9.5°	1.0435 ∠7.6°
V _S	-	1.0035 ∠-6.8°	1.0066 ∠-6.4°
V _R	-	1.0572 ∠-8.7°	1.0577 ∠-7.5°

Table 2: Results of power flow control of IEEE 14 bus power system on each branch

TL x-y	Base case		Case (1)		Case (2)	
	P (MW)	Q (MVar)	P (MW)	Q (MVar)	P (MW)	Q (MVar)
1-2	157.1	-20.5	154.4	-9.26	155.6	-9.52
1-5	75.5	5.6	77.5	2.87	76.49	0.797
2-3	73.5	3.5	74.53	0.324	73.17	0.441
2-4	55.9	1.8	-	-	56.58	-4.63
2-4_{S-R}	-	-	50	25	-	-
2-5	41.7	3.4	44.01	-4.041	-	-
2-5_{S-R}	-	-	-	-	40	25
3-4	-23.1	6.9	-22.08	0.072	-23.36	3.703
4-5	-59.6	9.1	-63.66	22.94	-59.7	-2.23
4-7	27.2	-5.9	-22.08	0.072	27.41	-5.08
4-9	15.5	2.9	-63.66	22.94	15.63	3.392
5-6	45.8	10.9	-22.08	0.072	45.33	15.65
6-11	8.2	8.7	-63.66	22.94	7.98	8.01
6-12	8.1	3.2	-22.08	0.072	8.0	3.07
6-13	18.3	9.9	-63.66	22.94	18.16	9.52
7-8	0	-23.1	-22.08	0.072	0	-22.9
7-9	27.2	15.7	27.13	16.54	27.41	16.29
9-10	4.5	-0.7	4.407	0.47	4.68	-0.07
9-14	8.7	0.47	8.713	1.205	8.86	0.854
10-11	-4.6	-6.5	-4.6	-5.35	-4.33	-5.89
12-13	-1.9	-1.37	-1.84	-1.22	1.819	-1.303
13-14	-6.3	-4.73	6.37	4.17	6.224	4.534

For both cases, the model proves its effectiveness and robustness. In case (1), the load flow analysis was settled after 10 iterations, and, in case (2) the load flow was settled after 11 iterations. Figure 6 shows the load flow iterations graph for each case.

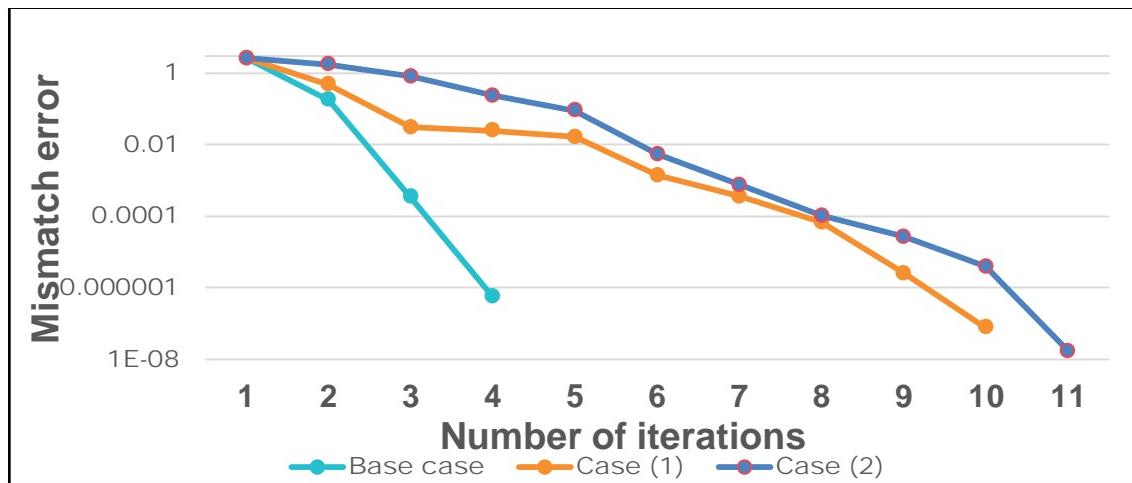


Figure 6: Load flow process iterations for IEEE 14 bus power system cases.

4.2 Testing in IEEE 30 Bus Power System

This system consists of 30 buses, 41 transmission lines, 5 generators, and 22 loads [17]. C-UPFC model is tested in this system in two cases as follows:

- Case (1): Controlling line 6 (connecting buses 2 and 6) with settings of active power $P= 90 \text{ MW}$, reactive power $Q= 40 \text{ MVAr}$, and center node voltage $V_{Sh}=1.0227$.
- Case (2): Controlling line 9 (connecting buses 6 and 7) with settings of active power $P=60 \text{ MW}$, reactive power $Q=-10 \text{ MVAr}$, and center node voltage $V_{Sh}=1.0455$.

Figure 7 shows the integration of C-UPFC in NEPLAN software on the system.

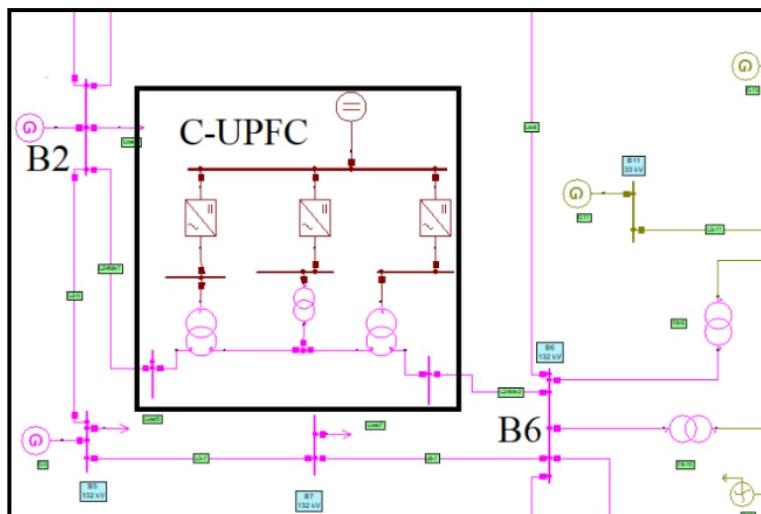


Figure 7: Implemented C-UPFC model integration on IEEE 30 bus power system

Table 3 presents the results of voltage control of the system buses, and Table 4 presents the results of power flow control on each TL in each case.

Again, the good performance of the model is shown in both cases, where the load flow analysis was settled after 7 iterations, for each case. Figure 8 shows the load flow iterations graph for each case.

Table 3: Results of voltage control of the IEEE 30 bus power system

Bus no.	Base case $V(\text{p.u.})\angle\theta^\circ$	Case (1) $V(\text{p.u.})\angle\theta^\circ$	Case (2) $V(\text{p.u.})\angle\theta^\circ$
1	$1.06 \angle 0.0^\circ$	$106 \angle 0.0^\circ$	$1.06 \angle 0.0^\circ$
2	$1.043 \angle -5.3^\circ$	$1.043 \angle -5.4^\circ$	$1.043 \angle -2.5^\circ$
3	$1.021 \angle -7.6^\circ$	$1.028 \angle -7.3^\circ$	$1.026 \angle -3.7^\circ$
4	$1.012 \angle -9.3^\circ$	$1.0168 \angle -9.4^\circ$	$1.0173 \angle -4.5^\circ$
5	$1.01 \angle -14.1^\circ$	$1.01 \angle -13.8^\circ$	$1.01 \angle -8.1^\circ$
6	$1.011 \angle -11^\circ$	$1.0208 \angle -10.5^\circ$	$1.0154 \angle -4.8^\circ$
7	$1.003 \angle -12.8^\circ$	$1.0087 \angle -12.4^\circ$	$1.0121 \angle -4.9^\circ$
8	$1.01 \angle -11.8^\circ$	$1.01 \angle -11.1^\circ$	$1.01 \angle -5.4^\circ$
9	$1.057 \angle -16^\circ$	$1.0613 \angle -15.6^\circ$	$1.0596 \angle -10.1^\circ$
10	$1.048 \angle -17^\circ$	$1.0529 \angle -16.6^\circ$	$1.0512 \angle -11.1^\circ$
11	$1.082 \angle -16^\circ$	$1.082 \angle -15.6^\circ$	$1.082 \angle -10.1^\circ$
12	$1.059 \angle -15.5^\circ$	$1.0613 \angle -5.3^\circ$	$1.0606 \angle -10.2^\circ$
13	$1.071 \angle -15.5^\circ$	$1.071 \angle -15.3^\circ$	$1.071 \angle -10.2^\circ$
14	$1.045 \angle -16.5^\circ$	$1.0473 \angle -6.2^\circ$	$1.0463 \angle -11.0^\circ$
15	$1.04 \angle -16.6^\circ$	$1.0431 \angle -6.4^\circ$	$1.0421 \angle -11.1^\circ$
16	$1.046 \angle -16.4^\circ$	$1.0498 \angle -6.1^\circ$	$1.0488 \angle -10.8^\circ$
17	$1.043 \angle -17^\circ$	$1.047 \angle -16.7^\circ$	$1.0456 \angle -11.3^\circ$
18	$1.031 \angle -17.5^\circ$	$1.0344 \angle -17.1^\circ$	$1.0332 \angle -11.8^\circ$
19	$1.028 \angle -17.7^\circ$	$1.0324 \angle -17.4^\circ$	$1.0311 \angle -12^\circ$
20	$1.032 \angle -17.6^\circ$	$1.0367 \angle -17.3^\circ$	$1.0353 \angle -11.9^\circ$
21	$1.036 \angle -17.4^\circ$	$1.0406 \angle -17.0^\circ$	$1.0389 \angle -11.5^\circ$
22	$1.036 \angle -17.3^\circ$	$1.0411 \angle -16.9^\circ$	$1.0394 \angle -11.5^\circ$
23	$1.03 \angle -17.1^\circ$	$1.0339 \angle -16.8^\circ$	$1.0326 \angle -11.5^\circ$
24	$1.025 \angle -17.4^\circ$	$1.0301 \angle -17.0^\circ$	$1.0282 \angle -11.6^\circ$
25	$1.022 \angle -16.6^\circ$	$1.0283 \angle -16.2^\circ$	$1.0257 \angle -10.6^\circ$
26	$1.003 \angle -17.1^\circ$	$1.0108 \angle -16.6^\circ$	$1.0082 \angle -11.1^\circ$
27	$1.028 \angle -15.9^\circ$	$1.0355 \angle -15.4^\circ$	$1.0326 \angle -9.8^\circ$
28	$1.01 \angle -11.7^\circ$	$1.0175 \angle -11.2^\circ$	$1.0134 \angle -5.5^\circ$
29	$1.009 \angle -17.1^\circ$	$1.0159 \angle -16.6^\circ$	$1.013 \angle -11^\circ$
30	$0.995 \angle -18^\circ$	$1.0046 \angle -17.5^\circ$	$1.0016 \angle -11.9^\circ$
V_{CP}	-	$1.0227 \angle -7.4^\circ$	$1.0227 \angle -3.2^\circ$
V_S	-	$0.9854 \angle -9.2^\circ$	$1.0158 \angle -3.4^\circ$
V_R	-	$1.0768 \angle -7.0^\circ$	$1.0191 \angle -3.3^\circ$

Table 4: Results of power flow control of IEEE 30 bus power system on each branch

TL x-y	Base case		Case (1)		Case (2)	
	P (MW)	Q (MVAr)	P (MW)	Q (MVAr)	P (MW)	Q (MVAr)
1-2	173	-21	181.3	-22.96	85.81	1.57
1-3	88	4.3	78.79	1.36	45.15	8.55
2-4	44	3.5	30.51	2.33	23.6	6.03
2-5	82.1	1.8	73.42	2.55	53	4.95
2-6	59.9	-0.1	-	-	26.25	6.12
2-6 _{S-R}	-	-	90	40	-	-
3-4	82.5	-3.9	73.88	-4.53	41.88	8.62
4-6	68.5	-17	48.56	-18.67	12.61	0.736
4-12	48.5	14.1	47.05	16.18	44.71	15.44
5-7	-15	11.2	-23.13	8.95	-42.44	15.34
6-7	38.4	-2.5	46.77	0.552	-	-
6-7 _{S-R}	-	-	-	-	60	-10
6-8	29.8	-5.6	29.66	20.86	29.97	4.15
6-9	17.2	-1.8	17.67	-0.572	18.54	-1.36
6-10	20.4	0.2	20.99	1.31	22	0.59
6-28	20	-10.4	20.52	-6.32	20.79	-9.08
8-28	-0.3	-2.3	-0.295	-6.44	-0.142	-3.86
9-10	17.2	9.1	17.67	8.06	18.54	8.28
9-11	0	-12.5	0	-10.2	0	-11.39
10-17	2.9	5.6	3.58	5.81	4.69	5.25

TL x-y	Base case		Case (1)		Case (2)	
	P (MW)	Q (MVAr)	P (MW)	Q (MVAr)	P (MW)	Q (MVAr)
10-20	7.7	4.4	8.04	4.51	8.61	4.18
10-21	14.5	10.6	14.47	10.58	14.6	10.59
10-22	6.8	5	6.76	4.99	6.85	4.99
12-13	0	-9.2	0	-6.38	0	-7.91
12-14	8.2	2.1	8.02	2.03	7.8	2.22
12-15	19.5	5.9	18.81	5.71	17.82	6.28
12-16	9.7	2.3	9.02	2.03	7.89	2.54
14-15	1.9	0.3	1.74	0.279	1.53	0.472
15-18	7.4	0.9	7	0.793	6.44	1.12
15-23	5.6	2.4	5.13	2.23	4.5	2.71
16-17	6.1	0.3	5.45	0.075	4.33	0.621
18-19	4.1	-0.1	3.75	-0.207	3.19	0.139
19-20	-5.4	-3.6	-5.76	-3.62	-6.31	-3.27
21-22	-3.1	-0.8	-3.13	-0.834	-3	-0.83
22-24	3.6	4.1	3.59	4.06	3.8	4.06
23-24	2.3	0.7	1.9	0.588	1.28	1.06
24-25	-2.8	2.6	-3.25	2.46	-3.66	2.91
25-26	3.5	2.4	3.54	2.37	3.54	2.37
25-27	-6.4	0.2	-6.82	0.042	-7.25	0.475
27-28	-20	-3.2	20.14	4.9	-20.58	-2.95
27-29	6.2	1.7	6.19	1.66	6.19	1.66
27-30	7.1	1.7	7.09	1.66	7.09	1.66
29-30	3.7	0.6	3.7	0.6	3.7	0.6

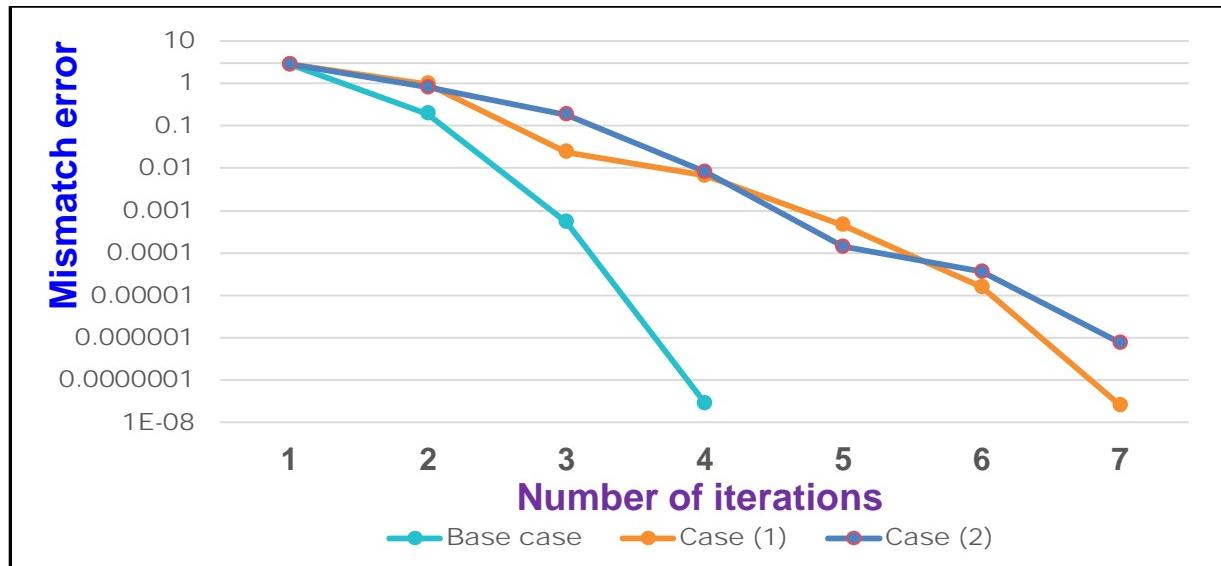


Figure 8: Iterations of load flow analysis for IEEE 30 bus cases.

5 Conclusion

This paper introduced a NEPLAN software-established C-UPFC model. This model implemented using the existed components in that software. The primary goal is to integrate a model of C-UPFC device for power flow calculations for systems involving such a device in NEPLAN software. Such a model is assessed in two power systems: IEEE 14 bus and IEEE 30 bus systems. For both systems, the model was installed in two different cases, including changing its position and control setting. It was tested so that it can provide active and reactive power flow control over the desired TL, besides controlling the center node voltage. For IEEE 14 bus, the load flow calculations were settled after 10 iterations for case 1, while it was settled after 11 iterations for case 2. On the other side, the load flow calculations were settled after 7 iterations in IEEE 30 bus for both cases. Such results show that the model was successfully simulated and it assures its versatility,

robustness, and effectiveness for load flow calculations so that it can be drastically utilized for power system analyses incorporating such a device in NEPLAN software.

6 Availability of Data and Material

Information can be made available by contacting the corresponding author.

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A. Awad received his B.Sc degree in Electrical Engineering from Higher Technological Institute (HTI), 10th of Ramadan city, and received his M.Sc degree from Aswan University. He is currently pursuing a jointly supervised Ph.D. degree in electrical engineering between the University of Jaen, Spain and Aswan University, Egypt. His research interest includes Optimization Techniques, Renewable Energy, and Smart Grids.



Dr.Salah Kamel is an Associate Professor in the Electrical Engineering Department, Aswan University. He received a joint Ph.D. degree from the University of Jaen, Spain (Main) and Aalborg University, Denmark (Host). His research includes power System Analysis and Optimization, Smart Grid, and Renewable Energy Systems.



Dr.Ali S. Alghamdi is an Assistant Professor and Acting Chair, the Department of Electrical Engineering, the College of Engineering, Majmaah University, Saudi Arabia. He received his dual B.S. degree (with high honors) in Computer and Electrical Engineering from Lawrence Technological University, Southfield, Michigan, USA, respectively, and an MSc in Electrical and Computer Engineering from Lawrence Technological University, Southfield, Michigan, USA. He received a Ph.D. in Electrical and Computer Engineering from Oakland University, Rochester, Michigan, USA. His research interests include Statistical Digital Signal Processing, Communication Systems, Adaptive Filter, Modern Control in Power System, Optoelectronics Nano-materials in Renewable Energy, and Wireless Sensor Network Innovation.



Professor Dr.Francisco Jurado is a Full Professor at the Department of Electrical Engineering of the University of Jaén, Spain. He obtained the MSc and Ph.D. degrees from the UNED, Madrid, Spain. His research activities have focused on Power Systems and Renewable Energy.



Professor Dr.Mohamed Zohdy works at Oakland University, Michigan, USA. He received his B.Sc. degree in Electrical Engineering, Cairo University, Egypt. He received his M.Sc. and Ph.D. degrees in Electrical Engineering, University of Waterloo, Canada. His interests are Control and Soft Computing.



Designing a Hybrid Model Using HSIC Lasso Feature Selection and AdaBoost Classifier to Classify Image Data in Biomedicine

Mukesh Madanan¹, Anita Venugopal²

¹ Department of Computer Science, Dhofar University, OMAN.

² IT Foundation Unit, Dhofar University, OMAN.

*Corresponding Author (Tel: +966(16)404-2568 Email: AAlghamdi@mu.edu.sa).

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Abstract

In cell-based research, an effective classification approach is required for visually monitoring a large quantity of image data of cells *in vitro* treatment. It is important to classify alive and dead cells likewise in tumor cell images, detecting virus-cell images, etc. to analyze patients' situation and then provide patient-centered care. Traditionally, the classification methods employed for classifying the cell microscopy data is time-consuming and is susceptible to faults and delusion. This is a serious and crucial dilemma. Accurate classification of data set is a major task in cell-based research as it determines the treatment. This paper introduces a hybrid model that uses a nonlinear HSIC Lasso feature selection method combined with the AdaBoost SVM Classifier to classify a large quantity of data effectively and efficiently. In the proposed model, object-based classification is executed within the bounds of the Waikato Environment for Knowledge Analysis (WEKA) interface. Besides, the accuracy of the classifier is evaluated by methods like feature selection and interactive learning in WEKA. The performance comparison of the proposed model amid existing classification approaches proved that the method is better in minimizing the mean absolute error value successfully.

Disciplinary: Computer Engineering, Biomedical Technology.

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1 Introduction

Cell image analysis plays a vital role in medical imaging after the invention of optical microscopes. During analysis, it is very important to classify the Alive and Dead cells to provide a

suitable diagnosis for patients' likewise in tumor cell images and detecting virus-cell images, etc. in the samples collected. Conventionally, manual applications are used to perform the investigation in microscopic imaging via a compact count of experimental facilities. In this case, a manual investigation of thousands of microscopy images, be that as it may, is tedious and prone to error. Hence, there is a need to employ computerized devices and techniques. Nowadays, researchers are giving more attention to the computerized framework and advanced techniques to enhance the efficiency in microscopic image analysis (Xing et al., 2017).

In recent years, morphological cell analysis is a developing new methodology to perform cell image processing or pattern recognition in a computerized manner. Correspondingly, it has integrated with many frameworks in biomedical applications such as evaluation of histological tumor sections, analyzing the characteristics of morphological biomedical cells, indicating cell morphology in various cell cycle progression or grasping the drug influences and chemotactic responses (Chen et al., 2012). However, morphological cell analysis has the challenge of identifying and classifying the cell growth variations of a large number of microscopic image data in visual monitoring of the cell-based vitro method.

Generally, the analysis of microscopy images has a major task of extracting the features and classifying the data from large image data set. Most of the state of art of image analyzing systems is tending to be expensive, complex, and hard to grasp (Baatz, Arini, Schäpe, Binnig, & Linssen, 2006). Thus, Machine Learning (ML) is developed for automatic image classification to classify the shape of living cells (Li et al., 2019). Still, the performance of the classifier can be enhanced by reducing the various surplus features (Popescu & Sasu, 2014). Moreover, it can reduce the redundancy to obtain high predictive features and interpretability. Also, to achieve accurate feature selection (Fan et al., 2004) and to minimize the unbalanced classification or prediction accuracy in image processing is a challenging one. Therefore, the ensemble learning boosting technique is a sophisticated solution for minimizing the errors in ML classifier to ensure performance accuracy (Dietterich, 2000). It can effectively unite various weak classifiers into a well-built classifier, which can attain a subjectively low error rate (Sagi & Rokach, 2018). Besides, by using the boosting algorithm, the impact of prediction and computation time is enhanced (Pavlov et al., 2002).

In recent studies, many frameworks have been developed to resolve cell microscopy image classification issues. However, the results are not satisfactory in large microscopy image data. In this paper, an effective feature selection method with an AdaBoost SVM classifier to easily identify the Dead and Alive cell from large datasets based on the object-based classification method with minimum error is presented.

2 Literature Review

Various feature selection and ensemble learning algorithms developed in existing researches are reviewed in this section. Peng et al. (2010) presented the feature selection method as a Sequential Forward Floating Search (SFFS) to prevail over the drawback of filter and wrapper method that has a high cost, low computational, and classification loss. They analyzed the

performance of classification by improving the search of the feature subset through the preselection step and then evaluated the achievement of single features and feature subsets of classification via Receiver Operating Characteristics (ROC) curves and this method efficiently solved the overfitting problem. But this method did not perform well while reducing the errors in classification besides it necessitates great computational power. Theoretical analysis of the minimal-Redundancy-Maximal-Relevance (mRMR) combined with the wrapper feature selection method (Peng et al., 2005) was introduced to minimize redundancy and it showed that maximal dependency condition is equal for feature selection and they analyzed different classifiers with various datasets. The analysis results proved that the accuracy has been enhanced but it lacks in the performance of large data analysis due to higher computation time. The Fast Correlation Based on Filter [FCBF] (Yu & Liu, 2003) approach was developed to reduce the redundancy to a sufficient level with fast computation. This method does not deal with the high dimensionality of data. To reduce the noise or redundancy, Sparse Additive Models (SpAM) were introduced (Ravikumar et al., 2009). Accordingly, the back-fitting algorithm was not supported to minimize the high-dimensional feature selection issues and it obtained nonparametric regression and classification. Further, dealing with non-additive models were not explained adequately. To override this, the Spectral features selection method (Wang et al., 2016) was presented to select features based on spectral clustering and l1-Norm Graph jointly. Lack of manifold structure, Unsupervised Spectral Feature Selection with l1-Norm Graph algorithm was optimized. It reduced the redundancy or noise for high-dimensional data in an excellent manner. Nevertheless, it supported only the unsupervised method effectively. To deal with unsupervised or supervised methods along with high dimensional data, Lasso was presented (Tibshirani, 2014). Lasso penalties approaches were useful for fitting to find out the drawback in low and large dimensional feature selection with (e.g. $n < 100$ and $d > 104$), l1 regularized. In addition to this, Lasso was used to supporting linear regression, and consequently, high prediction and accuracy were obtained. Correspondingly, HSIC Lasso was implemented to take over non-linearity (Takahashi, et al., 2020).

The sequential minimal optimization is an algorithm that offered to do the training in a faster manner in Support Vector Machine (Kotsiantis, 2007) which is used for minimizing the noise in feature data and enhance computational efficiency. The research aimed to discover a boundary, to maximize the margin connecting dissimilar data points for the splitting up by Sequential Minimal Optimization (SMO) Algorithm and also cooperating with non-linear data. However, the error was not handled at the requisite level. The ensemble method was presented to construct the classifier and to gain high accurate predictions while classifying the data by weighting the vote manner (Dietterich, 2000). In this way, high accuracy classification was achieved by constructing the correlations among input attributes using an ensemble Bayesian network in microarray data (Zhang & Hwang, 2003). Nevertheless, it did not provide support for nonlinear data analysis. The authors proved that the AdaBoost classifier well performed in error-correcting when compared with traditional state and art methods. Based on this, the shape of living cells microscopy images was

analyzed by Naive Bayes Classifier with AdaBoost (Theriault, Walker, Wong, & Betke, 2012). Thereupon, cluster mitigation was reduced and it obtained a classification in better form by minimizing false detection. This framework had high accuracy of classification but it supported only the linear model.

To enhance the classification in the machine learning method, previous researchers used various feature selection methods and classifiers but to solve the challenges in large data classification still seemed an issue. The research paper aims to introduce a significant classification methodology to provide an efficient classification of large quantities of data.

3 Classification

Based on the described existing methods, an efficient classification is needed for nonlinear high dimensional data. Also, it should be to reduce the noise, minimize time consumption, select the best feature, and avoid overfitting. To solve these constraints, the research aims at reducing the Mean Absolute Error in the proposed work. To follow the efficiency treatments *in vitro*, some metrics that are impacted by noise, time-consuming, misclassification is used to calculate the performance of classification in a large amount of cell microscopy images are revealed as follows.

3.1 Precision

Precision, which is a metric, is distinct as the total number of true positive divided by the sum of false positives and true positives. In biomedicine, Precision is called Positive Predictive Value. It is used to find the number of correct predictions. In classification, a low false-positive prediction means error or classification loss which is reduced the performance of classification.

$$\text{Precision} = \frac{\text{True Positive}}{\text{True Positive} + \text{False Positive}} \quad (1)$$

3.2 F-Measure

The harmonic (noise) mean of Precision and Recall is F – measure (Hand & Christen, 2018). It is denoted as F that is a function of Precision and Recall. It is used to measure the incorrectly classified cases in classification.

$$\text{Recall} = \frac{\text{True Positive}}{\text{True Positive} + \text{False Negative}} \quad (2)$$

$$F = 2 * \frac{\text{Precision} * \text{Recall}}{\text{Precision} + \text{Recall}} \quad (3)$$

3.3 Area under ROC

AUC (Area under the Curve) and the ROC (Receiver Operating Characteristics) curves combination are called as Area Under the Receiver Operating Characteristics (AU ROC). This evaluation metric is used to determine all possible classification thresholds. The AU ROC curve is based on the True Positive Rate against the False Positive Rate. AU ROC ranges value should be from 0-1. If the prediction is efficient, the value will be 1.0.

3.4 Time-Consuming

The performance of classification is affected by higher time-consuming. Thus, a fast manner calculation is important to analyze the data.

Cell-based research, as in tumor cell image and detecting the virus-cell images, is important to classify the Alive and Dead cell to detect the growth and un-growth or dead. Particularly in nonlinear high dimensional data, the efficient classification is a challenging one due to classification errors and misclassification. For attaining better classification results, we need to develop an accurate classifier. Thus, this research focuses on proposing a nonlinear HSIC Lasso feature selection method combined with AdaBoost SVM Classifier to reduce errors and misclassification efficiently.

4 The Proposed Hybrid Model

In microscopy cell image analysis, larger data classification is a major obstacle and most of the extant classifiers were unsuccessful to reduce the classification errors and are time-consuming. To solve this issue, the research introduces an object-based classification (Liu & Xia, 2010) method using nonlinear HSIC Lasso feature selection in conjunction with AdaBoost SVM Classifier to reduce the prediction error and time-consumption efficiently. This object-based classification is done using WEKA (Frank, et al., 2009) to evaluate classifier performance.

The microscopy images consist of a lot of noise and it creates a distortion of images in most cases. Besides, the noise-effected images minimize the accuracy of classification in a vulnerable way. To enhance the image quality, initially, the large cell-based image data is given as an input for pre-processing and the specific features are enhanced through correction of error and conversion of an image into an ideal format using a mathematical model. Further, in the feature selection process, the feature co-efficiency of discriminative features are found by separating the samples from different subsets. To achieve efficient feature selection, the paper proposes an HSIC LASSO feature selection algorithm to choose the best features from the training database by eliminating the redundancy features. Then, testing data and the selected features from the training data are fed into AdaBoost SVM classifier for the classification. In the classification process, the hypothesis ($h(t)$) is calculated by the SVM algorithm. Later with the help of AdaBoost, the training error ε_r and estimation of α_t is calculated and the weighted vectors are updated to obtain the weight of the hypothesis in the SVM classifier. AdaBoost could keep up the distribution weight of SVM iteratively and expanding its precision. Finally, the dead and live-cell data are classified with less computational time. Besides this, the Mean Absolute Error is calculated using an analysis of the metrics such as Precision, F- Measure, and Area ROC. The proposed hybrid model is depicted in Figure 1.

4.1 HSIC Lasso Algorithm

In 1996, Robert Tibshirani established the LASSO - Least Absolute Shrinkage and Selection Operator for regression or classification (Gauraha, 2018). LASSO can perform regression and feature selection in a powerful manner (Gauraha, 2018). Hence, LASSO feature selection is used to

find the admissible features in high dimensional data and facilitates to avoid redundancy and overfitting. Besides, it can achieve good prediction accuracy although it is supporting the linear data only. The research work analyzed the microscopic data in nonlinear methods. To do this, the Hilbert-Schmidt Independence Criterion Lasso (HSIC Lasso) (Yamada, et al., 2018) was employed in this research to support the non-linear high dimensionality microscopic cell image dataset.

The problem of optimization is exposed to Lasso as

$$\min_{\alpha \in \mathbb{R}^d} \frac{1}{2} \|y - X^T \alpha\|_2^2 + \lambda \|\alpha\|_1 \quad (4),$$

where $\alpha = [\alpha_1 \dots \alpha_d]^T$ is a regression coefficient vector, α_k indicates the regression coefficient for the k^{th} feature and $\lambda > 0$ is the regularization parameters. The feature base non-linear Lasso was proposed (Zhang et al., 2016), to get sparsely regarding features. The non-linear transformation is achieved through the feature-wise analysis. More explicitly, sample matrix X is obtained in a feature-wise aspect,

$$X = [u_1 \dots u_d]^T \in \mathbb{R}^{d \times n} \quad (5),$$

where $u_k = [x_{k,1} \dots x_{k,n}]^T \in \mathbb{R}^n$ denotes the k -th feature's vectors. At that point, using the nonlinear function $\varphi(\cdot): \mathbb{R}^n \rightarrow \mathbb{R}^p$, the feature vector of u_k and the output vector of y is transformed.

Then, the nonlinear Lasso based feature which also called HSIC Lasso² is

$$\min_{\alpha \in \mathbb{R}^d} \frac{1}{2} \left\| \bar{L} - \sum_{k=1}^d \alpha_k \bar{K}^k \alpha \right\|_{Frob}^2 + \lambda \|\alpha\|_1 \quad (6).$$

Useful features are selected using non-negativity constraints as " α ". Forasmuch as we utilize the output Gram matrix L to choose features in HSIC Lasso and organize the outputs via kernels. Besides, we can execute feature selection regardless of whether the training data set comprises of input x and its affinity information L , for example, connect structures amid inputs.

By using the linear combination of feature-wise input kernel matrices $\{\bar{K}^{(k)}\}_{k=1}^d$, regressing the output kernel matrix \bar{L} is got through in Equation (6). We represent that minimum redundancy maximum relevancy (mRMR) hinged on the feature selection method for HSIC Lasso, which is a well-known feature selection procedure in ML and AI communities. Considering this, Equation (6) can be composed as

$$\begin{aligned} \frac{1}{2} \left\| \bar{L} - \sum_{k=1}^d \alpha_k \bar{K}^k \alpha \right\|_{Frob}^2 = \\ \frac{1}{2} HSIC(y, y) - \sum_{k=1}^d \alpha_k HISC(u_{k,y}) + \frac{1}{2} \sum_{k,l=1}^d \alpha_k \alpha_l HISC(u_k, u_l) \end{aligned} \quad (7),$$

where $(u_k, y) = \text{tr}(\bar{K}(k)\bar{L})$ denotes empirical HSIC which is impedance matching depending upon kernel. The constant value of $HSIC(y, y)$ is possible to be unnoticed. Additionally, if redundant features are u_k, u_l , $HISC(u_k, u_l)$ holds a huge value and in this manner both of α_k and α_l will in general be zero. This process implies that the redundant features wiped out by HSIC Lasso. Thus, HSIC Lasso is lead to find non-redundant features based on (mRMR) feature selection methods (Ding & Peng, 2003).

The input of the Gaussian kernel is a desirable characteristic in the feature selection method. Computing the computational characteristic is so important. This property with HSIC Lasso using

$$\frac{1}{2} \left\| \text{vec} (\bar{L}) - [\text{vec} (\bar{K}^{(1)}, \dots, \text{vec} (\bar{K}^{(d)})] \alpha \right\|_2^2 \quad (8)$$

where $\text{vec} ()$ is noted as vectorization operator. This method is expensive when features are lower than the number of the sample (n). Therefore, the table peruse method is introduced to minimize the computation time and cost.

4.2 AdaBoost SVM Classifier

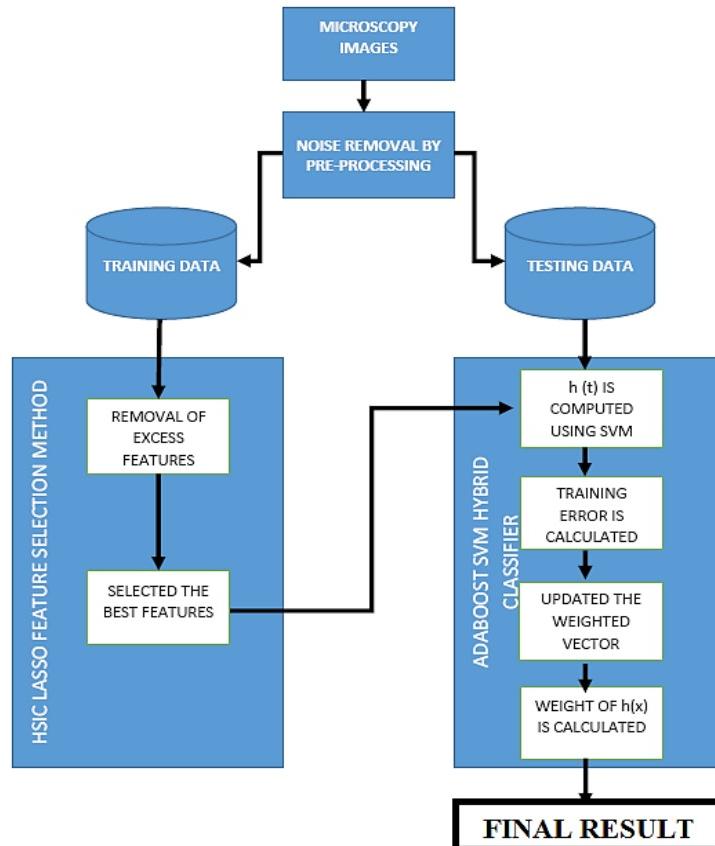


Figure 1: Proposed Model-HSIC LASSO with AdaBoost Hybrid Classifier.

The research proposes a hybrid model classifier (Ganganwar, 2012) to increase the performance of classification. Hence, the AdaBoost method with the SVM classifier is used as the base classifier. AdaBoost takes over the hypothesis weighting of the SVM method to acquire enhanced precision. The weight in misclassification error was enhanced in every cycle, the weight on the already well classified were minimized and leads to minimizing the potential weighted back in the subsequent cycle. Thus, the class (label) of hypothesis h_t was predicted.

4.3 Support Vector Machine (SVM)

Vapnik (1995) Support Vector Machine (SVM) Classifier can be used to find the decision surface which is located at a far distance from any data point. The distance amid the decision surface to the nearest data point creates the verge of the classifier. This method of development necessarily implies the decision function for an SVM and it is completely indicated by a subset of

the data which characterizes the location of the separator. These points are also known as support vectors. The Support Vector Machine is represented in Figure 2.

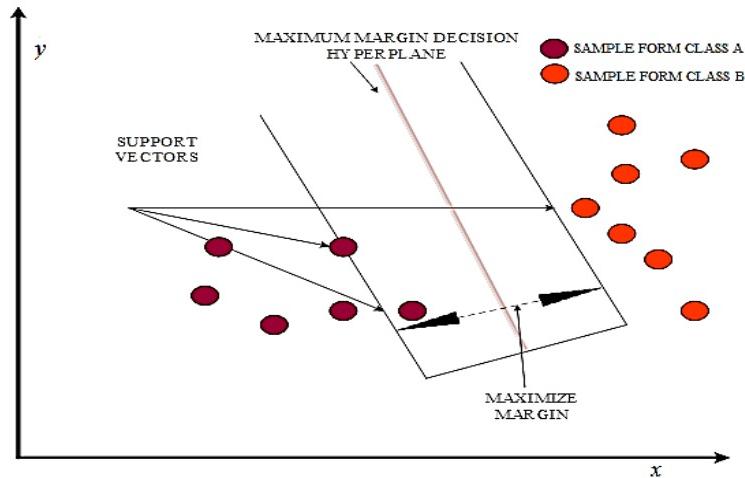


Figure 2: Support Vector Machine

It is finding the N number of features through the hyper-plane of the SVM algorithm that particularly classifies the data points. In classification, the major play of SVM is to assemble a hyperplane that can enhance the margin, the distance from the hyperplane to the nearest data. The larger margin generates a small error (Panca & Rustam, 2017). The margin was the nearest distance amid hyperplane to the closest point of each class (support vectors). Form of equation delineating the decision surface separating the classes is a hyperplane of the form as,

$$w^T x + b = 0 \quad (9)$$

where, w, x, b denotes weight vector, input vector and bias. The optimal hyperplane in SVM is shown in Figure 3.

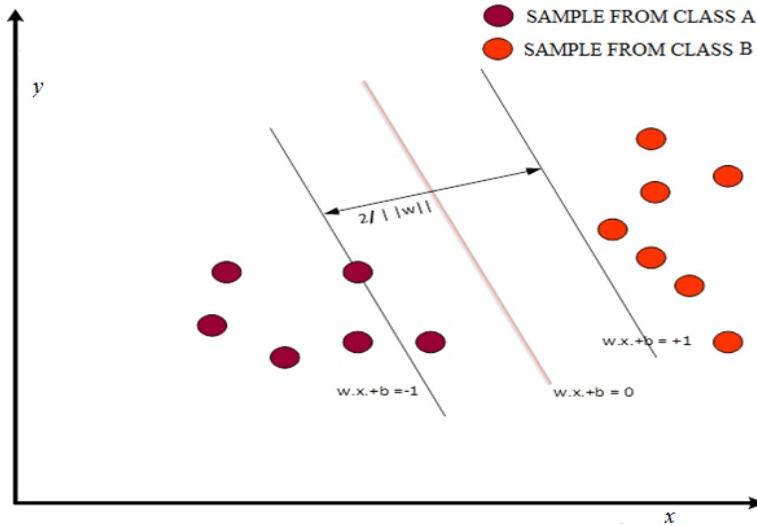


Figure 3: Optimal Hyperplane in SVM

The value of w and b are the findings through Quadratic Programming as shown in the mathematical model,

$$\min_{w, b} \frac{1}{2} \|w\|^2 \quad (10)$$

So that $y_i (w^T x_i + b) \geq 1, i = 1, \dots, n$

In this circumstance, the SVM finds and enhances the margins of the hyperplane to limit the classification loss. By adding C parameter and slack variable for classification error scenarios, the SVM mathematical model denotes

$$\min_{w, b} \frac{1}{2} \|w\|^2 + C \sum_{i=1}^n \epsilon_i \quad (11).$$

So that $y_i (w^T x_i + b) \geq 1 - \epsilon_i, \epsilon_i \geq 0, i = 1, \dots, n$

When enhancing margin, the algorithm attempts to keep the slack variable to zero ($C > 0$). Nonetheless, it does not limit the number of classification loss (NP-entire issue) but affects the total distance from the margin hyperplanes. C is signified as a trade-off margin width and classification loss. The kernel function includes the key idea to obtain linearly non-separable facts. The Kernel function is

$$K(x_i, x_j) = \phi(x_i^T) \cdot \phi(x_j) \quad (12).$$

It expresses a non-linear function and is obtained by a linear learning machine in a high-dimensional feature space while the limit of the system is constrained by a parameter that does not hang on the dimensionality of the space.

4.3.1 AdaBoost Algorithm

Yoav Freund and Robert Schapire presented AdaBoost in 1995 (Chengsheng et al., 2017). This technique has the object to keep a weight distribution w of the base classifier. Here, the learning algorithm takes a function from the hypothesis class, which is the set of possible classification functions. The ensemble method of AdaBoost can magnify the classification outputs by building a lot of classifiers and consolidating it. Then execute the base classifier training repeatedly for several cycles (1,2, ...T) with a given dataset. Starting weight vector w^1 in this training was arranged equivalent to

$$w_i^1 = \frac{1}{m}, \quad i = 1, 2, \dots, m \quad (13).$$

To get the exact result, the weighted vector is updated for each iteration. Finding hypothesis $h_t = \{-1, +1\}$ for w_i is a major task for the base classifier in this level and by calculating the training error ε_t to measure the quality of the hypothesis,

$$\varepsilon_t = \sum_{i=1}^m w_i^t \quad y_i \neq h_t(x_i) \quad (14).$$

In this manner, training error is determined from a trained weighted vector. This process is repeated until $\varepsilon_t > 0.5$. By limiting the estimation of ε_t , the expanded estimation of α_t is attainable as follow,

$$\alpha_t = \frac{1}{2} \ln(1 - \varepsilon_t | \varepsilon_t) \quad (15)$$

Thus, updating the weighted vector w_i^t is done. The result of the hypothesis depends upon the number of weights of the hypothesis in the base classifier as

$$H(x) = \text{sign}(\sum_{t=1}^T \alpha_t h_t(x)) \quad (16).$$

4.3.2 AdaBoost SVM Algorithm

The data set with the SVM algorithm with the number of cycles is provided as input. Then initializing the weight of the training sample is carried out and iteration is done until the last cycle. Based on the weighted training sample the hypothesis h_t is calculated using the SVM algorithm. The training error of ε_t is calculated using

$$\varepsilon_t = \sum_{i=1}^m w_i^t \cdot y_i \neq h_t(x_i) \quad (17).$$

This process is continued until If $\varepsilon_t > 0,5$ and stop it. Then set the weight for hypothesis h_t ,

$$\alpha_t = \frac{1}{2} \ln \left(\frac{1-\varepsilon_t}{\varepsilon_t} \right) \quad (18).$$

The weights of the training samples are updated too

$$w_i^{t+1} = \frac{w_i^t \exp\{-\alpha_t y_i h_t(X_i)\}}{Z_t} = \frac{w_i^t}{Z_t} \times \begin{cases} \exp\{-\alpha_t\}, & y_i = h_t(X_i) \\ \exp\{\alpha_t\}, & y_i = h_t(X_i) \end{cases} \quad \sum_{i=1}^m w_i^{t+1} = 1 \quad (19),$$

where Z_t is normalization constant.

The result of the hypothesis in (x) depend on the number of weights (T) hypothesis of the base classifier expressed as

$$H(x) = \text{sign}(\sum_{t=1}^T \alpha_t h_t(x)) \quad (20).$$

5 Results and Discussions

In this paper, the performance of the classifier is calculated by adopting the True/ False Positive Rate, F-measure, and receiver operating characteristic (ROC) area. The proposed method executes the huge number of the True Positive (TP) Rate and exactly marked the cell as ALIVE or DEAD divided by the sum of instances in the test set. Besides, many times the base classifier wrongly predicted the cell as ALIVE or DEAD, which are divided by the total number of instances in the test set and it has known as False Positive (FP). Further, the proposed model developed a ROC curve, through making the relationship of the True Positive vs False Positive of each classification threshold. In this, The Area Under ROC (AUROC) is used to calculate the accuracy rate of the classifier by changing the threshold value based on the ROC curve value. Then, the F-measure metric is used to analyze the classifier accuracy by computing the harmonic average of precision and recall. For perfect accuracy, the F-measure is on a scale of 0-1, with 1. The performance is higher if the F- measure value is on a scale of 0-1 or within 1.

WEKA's Explorer Environment is used to examine the performance of classifiers depending on the object-based model. Feature selection is a filter operation in WEKA. To evaluate the feature

selection method, ensuring the division of training data and testing data is important. The training data is designed using Sparse Attribute-Relation File Format (ARFF) file in WEKA (Bouckaert, et al., 2008) for the classifier. The suitable subsets of features are found through all possible combinations of attributes in the data. Thus, minimizing the excess features in the dataset and it is fed into the classifier. The WEKA's built-in algorithm for CV Parameter Selection was employed to object-based models. The meta-classifier of CV Parameter Selection tunes the parameter automatically as the base classifier. A specific range of values is given to perform the process frequently. The accurate value for the parameters is selected by CV within the provided range. For each object-based model, the batch size was tested over the range of 10 to 150. The tuning features are fed into WEKA's classifiers as input and the classifier performance is analyzed using ten-fold cross-validation belonging to the corresponding training set. The proposed model is compared with four existing methods and the comparison results proved that the proposed model outperformed while comparing with others in terms of False Positive Rate, area ROC, Precision, and F- Measure value.

As depicted in Table 1, the AdaBoost SVM classifier had 98% effectively classified instances. However, with Total Positive Rate, the value expanded to 98% compared with the existing classifier. The AdaBoost SVM classifier method has the build time of 0.01sec, which is equal to the Optimized SVM classifier although our proposed work has a better build in time. The AdaBoost SVM classifier reduces the False Positive Rate to a better level. The already existing classifier did not compensate AdaBoost SVM classifier in terms of precision or F-measure. Figure 4 represents the Area ROC values of Random Forest, Bayesian Network, SMO with SVM, and AdaBoostSVM algorithms.

Table 1: Result for Object Based Classifier Performance

CLASSIFIER	True Positive Rate	False Positive Rate	Area ROC	Precision	F-Measure	Time
Random Forest	0.90	0.10	0.967	0.90	0.90	0.04
Bayesian Network	0.90	0.10	0.939	0.901	0.90	1.41
Optimized SVM	0.95	0.05	0.951	0.95	0.95	0.01
AdaBoost SVM Classifier	0.98	0.03	0.985	0.98	0.98	0.01

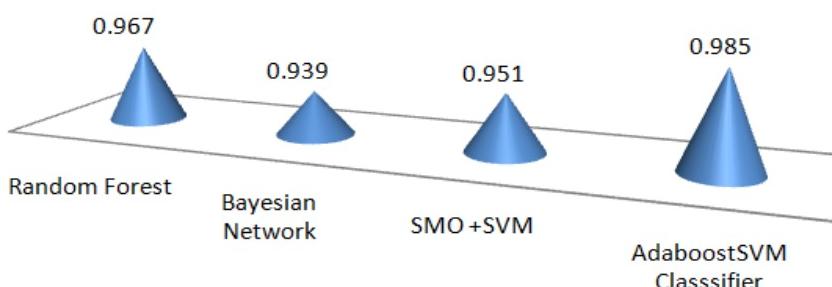


Figure 4: Area ROC Comparison

Table 2: Error Score Result for Classifiers

CLASSIFIER	Mean Absolute Error	Relative Absolute Error	Root Relative Squared Error
Random Forest	0.26	52%	61%
Bayesian Network	0.17	34.44%	80.98%
Optimized SVM	0.06	12%	48.98%
AdaBoost SVM	0.04	10%	41.25%

The high value of Area ROC indicates AdaBoost SVM classifier indicates better accuracy in classification as shown in Figure 4 Our AdaBoost SVM classifier is providing the most elevated accuracy in classification through enhancement of AUROC and effectively classified instances. The error score of the classifier is shown in Table.2. The measurement of error such as Mean Absolute Error, Relative Absolute Error, and Root Relative Squared Error for Existing classifier of Random Forest, Bayesian Network, Optimized SVM, and AdaBoost Classifier is calculated.

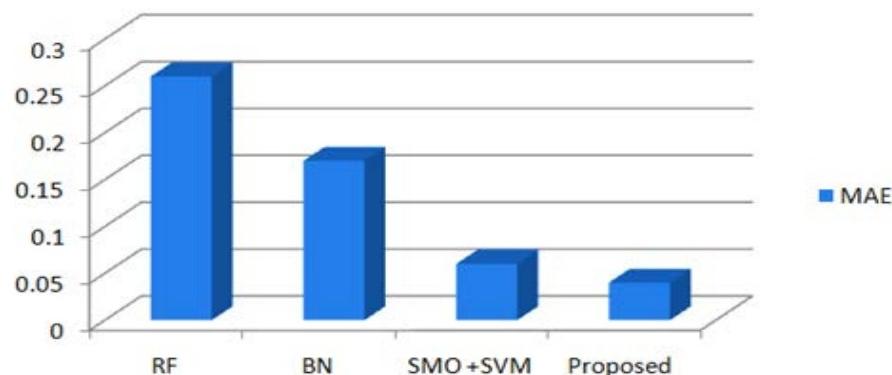


Figure 5: Mean Absolute Error Comparison of Classifiers

It is quite evident that the finest performance is accomplished by employing the proposed AdaBoost SVM classifier by reducing the Mean Absolute Error efficiently. The detection of Dead and Alive cell prediction is increased by reducing the Mean Absolute Error. Thus, the classification accuracy is improved compared with the accuracy of the existing classifier. The Mean Absolute Error comparisons are given in Figure 5.

6 Conclusion

This paper proposes a nonlinear HSIC Lasso feature selection method combined with AdaBoost SVM Classifier to obtain better classification results. In this work, the redundant features are reduced by adding the nonlinear HSIC Lasso feature selection method based on the Minimal-Redundancy-Maximal-Relevance method. Sequentially, the selected features are fed into an AdaBoost-SVM classifier. The AdaBoost algorithm boosts the performance of the classifier by adjusting the hypothesis weighting in SVM. The proposed method showed lesser error scores and the highest accuracy compared to its counterparts. Most of the existing methods failed to give better performance in huge dataset analysis although our proposed method gave the enhanced performance in terms of F-measure, Precision, and Area ROC. Also, the approach minimizes the Mean Absolute Error. This object-based classification performance is evaluated with the existing classifiers Random Forest, Bayesian Network, Sequential Minimal Optimized Support Vector Machine, and the proposed model outperformed well comparing with the existing methods. The research does not study the detailed structure of the cells while classifying. Using advanced image analysis and classification deep learning techniques such as CNN could enhance the results. For feature enhancements, very large data could be classified using neural network and pixel-based classification and can be implemented by using the feature extraction method.

7 Availability of Data and Material

Information can be made available by contacting the corresponding author.

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Mukesh Madanan is a Senior Lecturer of Computer Science at Dhofar University, Oman. He received his B.Tech in Computer Science and Engineering from M.G.University, India and got his MSc.in Software Engineering from the University of Portsmouth, UK. He is currently pursuing PhD in Information & Communication Technology at UNITEN, Malaysia. His areas of research include Machine Learning, Deep Learning, Robotics, Software Methodologies, IoT and Computer Networks.



Anita Venugopal is an IT Lecturer at Dhofar University, Oman. She is pursuing her Ph.D. in Computer Science at Motherhood University, India. The areas of research are Artificial Intelligence, Networks, and Knowledge Management.



Multifunctional Furniture as a Smart Solution for Small Spaces for the Case of Zaniary Towers Apartments in Erbil City, Iraq

Husein Ali Husein ^{1*}

¹ Department of Architecture, College of Engineering, Salahaddin University, Erbil, IRAQ.

*Corresponding Author (Tel: +9647504703157 Email: husein.ali @ su.edu.krd).

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Abstract

Most cities face problems with continuous population growth, while human needs remain the same or increase. Urbanization growth and marketing prices force citizens into less space. These problems lead to the appearance of small houses and flats. Many apartments fail to provide spaces with quality and comfort. Alter to multifunctional furniture solutions give full advantage of these reduced spaces while still achieving greater comfort, usability, and order in these spaces. This paper evaluates the impacts of multifunctional furniture on the space efficiency of apartments, through a survey that was conducted randomly among 258 units of the Zaniary Towers Apartments in Erbil city. This study finds that most participants have difficulties with their small spaces and supported the idea that multifunctional furniture can be a smart solution for their problems. Since furniture is a duty and a luxury, everyone needs it. Furniture occupies a lot of space and causes a lot of irregularity and wasted spaces. Flexibility in housing is designed to improve the quality of life in interior architecture. Multifunctional furniture as a flexible method can increase space sustainability and improve the quality of living by serving several functions at once. These types of flexible furniture can balance spaces in terms of beauty and efficiency.

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1 Introduction

Most societies are struggling with the growing population and urbanization, due to more desire for housing in the cities that lead to the appearance of small apartments (Urist & Beriot,

2013). A preferred progressive lifestyle, economic scale, and lack of space for living force middle-class populations to live in apartments and flats. Basic human needs should be maintained in apartments to support human wellbeing. One reason for individuals' dissatisfaction in cities is related to the lack of space in their homes.

The definition of what constitutes a small apartment is has changed. Almost 20 years ago a small apartment needed a floor space of about 70 square meters. Today we have some apartments' floor space of 20-30 square meters (Kilman, 2016). While the total area of apartments has been reduced, furniture generally still needs the same space as before. The main problem for users of these apartments is the lack of space for all necessary furniture. As human needs are still the same or greater than before, we all want furniture that makes a difference in everyday life.

Most small apartments only have multipurpose rooms intended for several activities like studying, watching TV, having dinner, family gathering, etc. (Canepa, 2017). Often, there's a lack of space in these rooms,-: however, a human being needs to feel space; when many things and furniture surround them; they can get stressed and overwhelmed. It's necessary to have enough must-have furniture to organize space in these apartments.

The main goal of this study is to investigate the impacts of multifunctional furniture on the space efficiency of small apartments to improve human well-being. Before the innovations in furniture, creativity in furniture only aimed to improve look and functions. But today saving time, space, and reducing human effort should be a consideration for furniture designs mainly for domestic use.

By definition, furniture is a group of design items and pieces that give useful functions for activities of daily life like eating, sleeping and supporting, serving, and sanitation. In previous decades, furniture was built by some existing natural material like wood, but innovations have made it possible for furniture to be built from different materials like; plastic. Choosing the material can affect both the load capacity and appearance of objects (Gentili, 2017).

Furniture is intended to build an easier and more comfortable life for human beings (Astonkar & Kherde, 2015). For centuries, furniture was designed for only one function per piece. For instance, wardrobes and cabinets are made for storage use, sofas, and beds for human rest, tables, and chairs for dining.

Today, many types of space-saving furniture products are available like foldable chairs and tables. One of the most common space-saving pieces of furniture in regular use in residential buildings is the sofa-bed, which can be used both as the sofa and a bed. These pieces of flexible furniture help peoples who live in small apartments with small spaces. They are flexible and comfortable for converting, for instance, a sofa-bed can be easily changed to function as a bed at night and rearranges-back quickly to serve as a sofa in the day. Furniture that allows flexible use of space should be: sustainable, inclusive, reconfigurable, durable, and upgradeable (Gómez-Carmona, et al., 2018).

Multifunctional furniture is space-saving furniture that can serve more than one function. There are many types of multifunctional furniture for living areas that customers might choose, including space-saving beds and tables as they have more functional properties than other multipurpose furniture because they are among the most-frequently-used piece of furniture (Xie, 2016). Multifunctional furniture is a revolution for furniture design as their designs do not only make them a smart solution for small spaces but also make them look more pleasing aesthetically. It is an approach to space sustainability that, at the same time, serves all kinds of functions.

2 Literature Review

2.1 Population and Urbanization Growth

Living in small spaces is not a new experience. For many years, humans have been living in small flats and apartments like in China, and throughout Asia, and other parts of the world, due to large populations in major cities and people's movement from villages into cities (Beardmore, 1971). The UN's urbanization report 2014 declared that the number of the citizen will increase by 66% in big cities by 2025 (United Nations, 2014).

This increase in urbanization is due to more people in big cities that will result in higher demand for apartments. This urban growth is a big issue for which the Western world suggests small apartments as a solution (Tokuda, 2004).

Globally, people who live in urban areas are more than those who live in rural areas. In 2007, for the first time in history, the global urban population exceeded the world's rural population. The world population has remained mostly urban since then (United Nations, 2014).

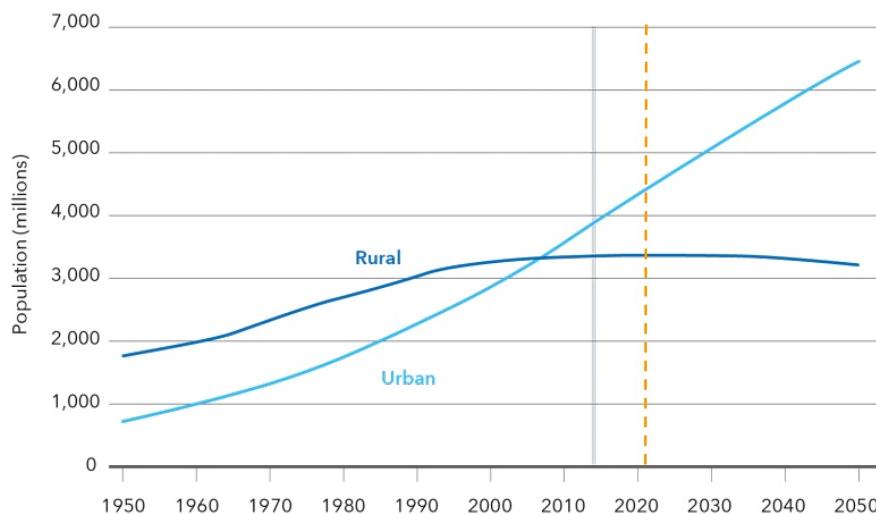


Figure 1: The increasing population of the world (Source: DESA, U.N. (2014)).

2.2 Small Apartments

Georgoulas, et al., (2012) mentioned that the minimum bedroom area in an apartment is about 6-9 m². Most apartments are divided into small units, which makes the apartments smaller. An open plan would be a great choice for a small apartment design. The high desire for apartments results in high marketing prices.

Many of the existing small apartments have only one or two rooms, multipurpose spaces that should be utilized for several activities. Figure 3 shows that there is only one space to be used

as living room, bedroom, and kitchen, this small space can serve multiple functions. Multipurpose spaces in apartments can lead to a crowded feeling or even a psychological perception of insufficient space (Kilman, 2016).

The design of apartments' indoor space strongly affects the comfort of the occupants. Author Farah Nasser posits, if the interior is not well designed, this could add stress to individuals' psychology (Nasser, 2013). The author also discussed that housing can affect human health both physically and psychologically and the occupants' perception of him- or herself. Humans have different psychological responses to different designs of interiors. And the furniture is an important part of interior design.

Residents of apartments also often don't have enough space to accommodate their furniture. Apartments, despite their downsides, have many positive aspects, especially environmentally as these small apartments need fewer resources to construct and maintain than single-family homes. This reduces the human footprint on the environment (Gentili, 2017).

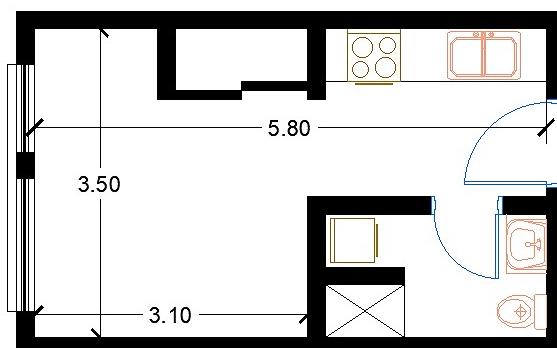


Figure 2: A small apartment with an approximately floor space of 20 m² (Created by the Author).

2.3 Importance of Furniture in Apartments

A piece of furniture is a movable piece that is made to help human daily activities like a chair for sitting, beds for sleeping, and a wardrobe for storing stuff. It is an important element in a room that can be designed based on the desired use. Before designing any type of furniture for space it is necessary to study the furniture user's preferences and needs (Vaida, et al., 2014). Sometimes a piece of furniture maybe a piece of art, have a symbolic or religious purpose, or, for instance, big-scale furniture can show the owner's status.

While furniture that we use daily is usually placed inside of buildings and is typically smaller than the buildings, furniture and architecture have similar or rather mutual attributes. From functional aspects, both aim to build an object that fits human activities and ease human life. Both should be appealing to the eye and fit human psychology (Chen, 2016). Many types of domestic furniture are available for various functions (Kilman, 2016). Design and the placement can make a difference in people's mood; as Gentili, (2017) stated, furniture selection can complement or diminish human needs and feelings; for example, furniture intended for storage may be difficult to move and thereby frustrating for people. So furniture design can be treated as a type of mini

architecture. Furnishings can achieve sustainability through innovation in structure, space efficiency, and material saving.

Tsunetsugu, et al., (2005) showed that different substances used within spaces, whether as decoration or furnishing materials, such as wood, caused various physiological responses, especially in involuntary nervous activity. Today architects and designers are rapidly developing a variety of concepts in collaboration; thus fusion of architectural and interior elements is more evident than ever. Endeavors striving for space optimization and compact functionality in furniture design have become some of the main sources of inspiration for achieving maximum functional flexibility of spaces (Gjakun, 2015).

Furniture is a crucial part of an apartment as it takes up about 50% of the floor space, according to this study; the most common furniture in the apartment is a bed, sofa, chair, table, wardrobe, and commode. Because there is not enough space in apartments to accommodate all these pieces of furniture at the same time, the demand for multipurpose space-saving furniture is growing (Xie, 2016). Furniture can influence space perception in a room. Some visual tricks can be performed when arranging furniture to make a space look much larger than it really is (Schneider & Till, 2005).

2.4 Multifunctional furniture

The issue of small spaces can be solved by some smart solutions like multifunctional furniture, modular furniture, and well-designed space, they all increase space efficiency (Estaji, 2017). Multifunctional furniture is known by several names; space-saving furniture, transformable furnishings, and also multipurpose furniture; furniture that is designed in a way that serves multiple activities and purposes at the same time. This kind of furniture has been made and used for many years, but until now the importance of these versatile furnishings has not been absolutely recognized (Canepa, 2017).

Multifunctional furniture denotes pieces of furniture that adjust with different applications by transforming spatial relationships of their pieces. Sometimes modification needs skill; such kinds of furniture can be quite costly as it adapts for different applications at the same time. Multifunctional items like foldable, stackable, and transformable furniture are great solutions for maximizing small spaces. Various types of such versatile furnishing are available on the market, for example, Figure 3 depicts multipurpose furniture that can work as a table, chair, bookshelf, and a wardrobe at the same time (Farjami, 2014).

Another solution to small spaces consists of multifunctional transformable furniture that fits apartments (see Fig 4). For these kinds of solutions, built-ins on the walls consist of several pieces of furniture. As you open a door, you pull out the bed at night time; during the day, you simply close the door, and the back of the bed acts as a wardrobe, a table, etc. (Wang, 2013).

According to Gomes, et al. (2015) an apartment is a shelter, a home for many people, and home should provide the needs of the residents to make them feel comfort and peace and to offer a healthy and good environment. Because most apartments in densely populated cities are too small

for holding all basic furniture, the need for multifunctional furniture is significant. Due to small spaces, residents have to use space for multiple purposes and adapt it for different activities. These days, due to lifestyle changes, people do not like adding extra steps to their daily activities.



Figure 3: Modern multifunctional furniture ideas for small spaces
(Courtesy of TAD, The Architecture Design, 2020).

2.5 Interior Flexibility

The basic notion is a transformable furniture space. Functions could change during different periods in one day. To transform the space into different functions, the furniture needs to be meticulously designed to suit different conditions. The daily activities of the residents inside small apartments are sleeping, studying, eating, and party time. Different furniture is needed for different activities.

Efficiently organize different furniture within a small space is quite a difficult task. The idea is to transform the space into a bedroom, a study room, a party room, etc. In this way, the maximum use of a minimum space can be achieved and people will not feel the limit of the furniture around them (Zhang, 2016).

To free up a small space for different functions, the furniture must have specifications that suit the necessary functions and need little space.

Most of these apartments cannot provide comfortable living conditions for the users; various problems are listed to show the basic needs of residents of residential units with small spaces. Some of the occupants are individuals, but most of them are with their families. In such a case, the size of families can vary from one family to another. Families are consisting of parents with their three children living in such small apartments. There is the same problem even for small families. It is impossible to arrange all the essential items for one family in these small spaces. The necessity to create larger spaces is also impossible to accommodate needs.

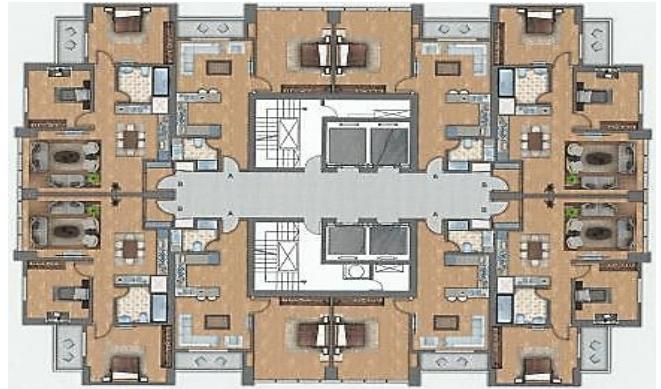
3 Case Study Description

The case study will be undertaken at an apartment complex comprised of three towers of equal shape and height. The main tower consists of apartments, while the business center is still under construction. There are 5 types of apartment floor plans ($48m^2$, $58m^2$, $66m^2$). The ground floor plan is slightly different from floor plans, which are the typical plans, Figure 4. These 23 floors

with two types of plans: Type A (1+1) with 58 M² and Type B (1+2) with 66 M². The other two upper floors have only two other duplex units. Each of the three towers contains 84 units of Type A (1+1), 84 units of Type B (1+2), 4 units of Type C (3+1), and 4 units of Type D (4+1). In large units with larger areas, the number of rooms is increased, but the area of each room remains small. In the main tower, which is under construction, there are very small units with much fewer spaces and areas.



(a) Zaniary Towers GF plan in Erbil city



(b) Three Towers 2nd- 22nd Floor Plan

Figure 4: Zaniary Towers Project office (Courtesy of Kirmanj Construction).

4 Methodology

To understand the impact of multifunctional furniture on space efficiency in a small apartment, it was important to gain knowledge about what previous researchers have found about multifunctional furniture in the literature review. This part aims to investigate the impacts of multifunctional furniture in small spaces.

A flexible research approach (survey) is used as a method for data collection. The questionnaire is designed according to the factors from studies that were previously reviewed in the literature review. I tried to compile a short questionnaire with multiple choice answers mostly so that people could respond easily in a short time. The questionnaire includes questions regarding apartment residents, furniture needs, preferences, and recommendations, their living conditions in their apartments, and how people like the furniture in their apartments.

Participants were comprised of 126 residents of small apartments in the “Zaniary Residential Towers” in Erbil City. Participant’s ages ranged from 22-56 years, and the mean age was 33 years. Out of 120 questionnaires, which were carried out randomly, 103 were returned and answered. A qualitative approach was used to demonstrate the importance of multifunctional furniture in improving the quality of life in small apartments. The Statistical Package for Social Sciences (SPSS) software program was used to analyze the data.

5 RESULT AND DISCUSSION

5.1 Findings from Apartment Residents Questionnaires

One questionnaire question inquired, “How many family members reside in your home?” We see in Table 1 that most of the apartment residents, to be precise 53.5% couples with children, which means three and more than three people are living in one apartment with 48 m² to 66 m². Of

the participants, 30% are two people living together. Only 16.5% of the occupants of the apartments are single.

Table 1: The apartment's Households by Family Type

Resident Numbers	Frequency	Percentage
Single	17	16.5%
Couple without children	31	30.0%
Couple with children	55	53.5%
Total	103	100.0%

Furthermore, the questionnaire asked about the participants' satisfaction with the furniture inside their apartments. Evidently, 41% of the participants were currently experiencing difficulties with their furniture and showed dissatisfaction (Table 2). Only 19.4% indicated that they felt comfortable with their furniture situation, and 26.1% gave a neutral vote.

Table 2: Level of satisfaction with furniture they have

Levels of satisfaction	Frequency	Percentage
Very Satisfied	4	3.8%
Satisfied	20	19.4%
Neutral	27	26.1%
Dissatisfied	42	41.0%
Very dissatisfied	10	9.7%
Total	103	100.0%

After sharing their furniture problems, participants were asked to share their recommendations for a solution. Out of 103 participants, 64 of them preferred multifunctional furniture (see Table 3) and stated that it can be a proper solution for their problem of small spaces and lack of furniture. Meanwhile, 39 of them (37.9%) did not believe that multifunctional furniture would solve their problem and still preferred traditional fixed furniture.

Table 3: Participants' preferences according to types of furniture

Furniture type	Frequency	Percentage
Multifunctional furniture	64	62.1%
Traditional fixed furniture	39	37.9%
Total	103	100.0%

5.2 Discussion

According to the survey, which was conducted with 103 apartment residents, traditional single-function furniture needs to be transformed or replaced by multifunctional furniture to make the most of space and improve the quality of living in small apartments. In most of the apartments parents with children are living together, so 53.5% of apartments house three or more than three people while the area of these apartments was less than 70 m²; accordingly, they did not have enough space to accommodate necessary furniture like beds, a sofa, a wardrobe, a table, chairs, and cabinet, although these pieces of furniture have become a necessity in these days. Only 19.4% of the residents were satisfied with the furniture situations inside their spaces. This finding is aligned with the results of the study by Nasser (2013). So most of the residents had difficulties with their

furniture and believed that multifunctional furniture can be a good choice for solving their problems, make them more comfortable and less crowded in their homes. Furniture also could improve the socialization of families with their social and family environment. But because, in our country, multifunctional furniture is something new, 37.9% of the household do not support the idea that multifunctional furniture would be a smart solution and still prefer traditional furniture.

Furniture is an important part of an apartment. It is taking up about 35-45% of the floor space (Waswo, 2013). Participants believed that the most necessary pieces of furniture to have in an apartment are a bed, a wardrobe, and a table. According to Wang (2013), some furniture items are more or less obligatory in this century to have in every home (see Figure 5). But due to small living areas, apartments cannot always accommodate all the necessary furniture.

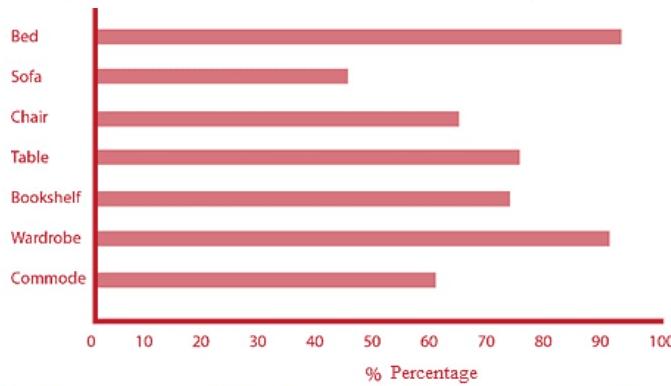


Figure 5: Importance of furniture type in apartments (Wang, 2013).

6 Conclusion

The main purpose of this paper was to examine the importance of multifunctional furniture to increase space efficiency in small apartments. As population and urbanization grow, more small apartments are built. According to a questionnaire that was given to apartments' residents, most of the apartments had a problem that small spaces could not hold enough furniture. With the help of multipurpose furniture, it is possible to meet the various needs of residents in a limited space. It's a major category of flexible furniture that helps to create flexible ideas and optimize the use of housing. Today's designs are intended to maximize efficiency, comfort levels, and productivity in small spaces. One of these solutions is multi-purpose and custom-made furniture, which, as its name implies, is built to serve in more than one application at the same time, covering more space and occupy less space. Multipurpose furniture is a smart idea that reduces many problems in small spaces because they occupy a bit of space, they also offer other uses which lead to enhance the user's comfort in using space. As furniture occupies a lot of space and causes a lot of irregularity and cost, in the case of a very small space, it does not only fail to address the problems of the organization but also increases difficulties in daily activities. Multi-purpose furniture can balance space and give beauty and efficiency to small spaces. Modern multifunctional furniture is one of the best choices for places with space constraints. This research can be a flexible foundation for further research in the field of flexible multi-purpose architecture on the scale of internal architecture; indoor environments should be satisfying to motivate users. More investigations into flexible furniture designs are required to further explore multifunctional types of flexible furniture.

to enhance space sustainability. Design and art should always be created based on the needs of the society and solve the issues to provide people a better living environment, that is why the multi-function furniture and product design needs more attention and development.

7 Availability of Data and Material

Information can be made available by contacting the corresponding author.

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Dr. Husein Ali Husein is an Assistant Professor of Architectural Engineering and competence of Architectural Technology in the Department of Architecture, Salahaddin University –Erbil. He gained a B.Sc. degree in Architectural Engineering from the University of Technology- Baghdad, an M.Sc. degree in Architectural Engineering and Public Building Design from TU-Berlin, and a Ph.D. degree in Architectural Technology from the University of Sulaimania.



Library Professional's Resistance to Innovation: An Empirical Examination of Technostress in Punjab's University Libraries

Abida Hanif^{1*}, Salman Bin Naeem¹, Rubina Bhatti¹

¹ Department of Library Information Science, The Islamia University Bahawalpur, PAKISTAN.

*Corresponding Author (Email: abidahanif37@gmail.com).

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Abstract

Resistance to technology leads to a response like direct rejection, postponement, or opposition. Technostress is a modern disorder of adaptation that highlights an individual's incompetency to handle new technologies in a dynamic environment of knowledge. This study explores the hypothesized relationship between the technostress and resistance to technology adoption among the Library and Information Science (LIS) professionals working in the university libraries of Punjab Pakistan. The Survey research method was used to collect the data through a convenient sampling technique from the population. The data were analyzed using SPSS and Analysis of a Moment Structures (AMOS) to check the relation between the variables and testation of the hypothesis. The study enclosed with these findings. Technostress has a positive effect on the resistance to technology adoption in university libraries. These factors were found significant. The prevalence of technostress among male respondents was slightly higher. The intended research is beneficial for LIS professionals. It is recommended that short courses on stress management and technology handling be organized for LIS professionals. In Pakistan, this study was the first attempt that investigated the relationship between technostress and resistance to technology. This study is a part of a doctoral dissertation aimed to gain insight into the technostress, its effect, and possible ways to overwhelm the library professionals, especially the old age ones.

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1 Introduction

Information technology (IT) has revolutionized our daily lives like teaching, businesses, law, banks, medicine, police, airline systems, and homes. Libraries are an equally important measure of any society. It also needs development and growth in this technological revolution. Dahlbom (1996); IT emerged in the 1970s as an outcome of new products in the daily lives of people. Similarly, IT is embedded in things (e.g. Internet of Things (IoT)) and is used widely in every activity of life. Marcum (2016), Mulla (2006), Aslam (2018) stress that the influence of technology in library operations, services, and resources cannot be underestimated, and it is assumed that for the proper functioning and useful communication libraries will get dependent upon information technology in a year or so. Information is a basic need of life, and IT has brought significant variations in information generation, organization, process, storage, access, retrieval, and utilization (Husain & Nazim, 2015; Aslam, 2018). The conventional library practices (printed collection) were replaced with electronic resources. Besides, Zanin-Yost (2004) observed that users' faith in digital and electronic resources multiply day by day in response to variation in the process of information generation, storage, and retrieval process in academic libraries. The literature reveals that Pakistani libraries can access information technology, but many organizations do not achieve full benefit from technology because many personnel resists using them (Malik and Mahmood 2014; Khan et al. 2015; Tralagba & Akpan, 2019). The question arises that why academic librarians are not willing to adopt information technology.

The research purpose was to discover the consequences of technostress on the resistance to the adoption of technology in Pakistan's libraries. This exploration is an endeavor to fill up that gap and provides a more in-depth insight into the resistance in the adoption of technological applications in the Pakistani university libraries. This study will help library managers and decision-makers to overcome this stress.

2 Literature Review

The technostress has been studied as a significant construct in various studies. It is vital to have a general analysis of technostress and resistance to technology adoption (RT). Despite all the advantages of using the new technology, many practitioners and researchers confirmed in their research studies that resistance of individuals to information systems is a primary reason for the failure in the execution and adoption of novel technology. Further, Siegel (2008) demonstrated that technology resistance means unwillingness to take the initiative, idea, action, or different unpleasant circumstances. According to Mirkamali (2000), change cannot be implemented quickly and successfully. Lack of understanding, reluctance, and unpreparedness of the workers are the main reasons for the resistance when encountering changes.

The word resistance means "the refusal to accept or comply with something, the attempt to prevent something by action or argument" (Coetzee & Stanz, 2007). The integration of new technology causes fear and distress for many individuals, and it has been observed that resistance is a natural reaction to any change. Resistance is a complex phenomenon. The literature revealed that

the research on an individual's behavior is vital because their perception of innovative technology plays a noteworthy part in any resistance to innovation. An individual's resistance to innovation is significant due to its positive and negative consequences like success or failure (Yu et al., 2015; Mohtar & Abbas, 2015). Similarly, Tarafdar et al. (2007), Tralagba & Akpan (2019) discovered that personnel is facing technostress due to technology use in organizations.

Resistance to technology merely "refers to pushing the adoption decision to the future." Resistance refers to "protesting or searching for further information after the trial." Rejection refers to direct contradiction actively or passively (Mirella et al., 2009; Szmigin & Foxal, 1998; Ram, 1987).

A standard definition of resistance can be anticipated as "any behavior or reaction that a person shows when facing the changes, behavior or reaction that leads to termination or slowing down the process of changing." The literature revealed that stress is a supposed phenomenon related to anxiety and tension while using technology. Technostress is a modern disorder of adaptation that highlights an individual's lack of ability or incompetency to handle new technologies in a dynamic environment of knowledge (Brod, 1984). It is defined as a physiological and emotional reaction that results from the response to this perplexing environment (Greenberg, 2005). Similarly, in another study, Ahmad et al. (2012) investigated that technostress is a novel sort of stress that marks technology's impact. Furthermore, Tarafdar et al. (2007) defined technostress as a person's inability to cope with information and communication technologies (ICT).

The prevailing literature identifies a strong connection between technostress and resistance to the use of technological tools. Thatcher (2005) discovered that smartphones create technostress among users. Moreover, Sweeney and Summers (2002) explored how technology affected management related issues, personnel change, and stress source. It revealed that inadequate formal training and poor technical support are the main reasons for technostress in any organization.

Only a few studies were conducted on the relationship between the computer and demographic variables like age, gender, experience, and education. Most women are considerably less relaxed than men in coping with computers and technology (Qutab et al., 2014). Moreover, Ayyagari (2008) recognized a negative relationship between job satisfaction and technostress and further expounded that technology hesitation is a robust forecaster of job discontent among the workers. Similarly, Tarafdar et al. (2007) and Tralagba and Akpan (2019) exposed that personnel is facing technostress due to the use of technology in administrations.

Technostress is an important variable as it is a strong determinant of voluntary behavior (such as to adopt new technology tools or not). As mentioned above, literature exposed that technostress exists and has been measured physically in the context of e. learning and resistance to adoption of the digital libraries (Hayashi et al., 2020; Nov and Ye, 2009). This study aims to find the association between the technostress and resistance in adopting technology in the university libraries. Hence, it is assumed that:

Hypothesis: There is a significant association between technostress and resistance to technology adoption.

Grounded on the literature review, this research study is based upon the RAM'S (1987) model. This model pinpoints the importance of an individual's behavior, particularly in the viewpoint of resistance to innovation. This research aims to understand the association between resistance and technostress to the adoption of technology within the perspective of library professionals serving in the university libraries. This model is useful to evaluate the empirical data that has been collected through questionnaires. Technostress is treated as an independent variable in this model and technology resistance is taken as a dependent variable.

The use of technological tools in the libraries and information centers has brought a positive move (Ahmad, 2009). Contrarily, this positive move has been observed as stress or phobia among library professionals. This stress is known as technostress, due to the continuous use of information technologies in performing the library functions that were initially done manually.

The use of technology in the libraries creates stress among library professionals and negatively affects the organization (Ahmad. 2009; Tralagba & Akpan. 2019). This study determines the effect of technostress on resistance to technology adoption in the libraries by measuring their relationship.

The literature shows limited studies on the association between the technostress and resistance to technology adoption in Pakistan's university libraries. This research has also added to the body of knowledge and provided deep insight from the Pakistani perspective. This study's outcomes support the reduction of the resistance of library managers serving in university libraries in Pakistan.

3 Research Methodology

The primary data was collected through a survey comprising the questionnaire and the quantitative method was adopted to conduct the study. The respondents were LIS professionals having a master's degree or above in the subject of library & information science and working in the university libraries of Punjab, Pakistan. Respondents were offered a five-point Likert scale to measure their personal opinions. A questionnaire was designed to assemble data from the respondents using an online (Google Forms) survey tool. A sample of 150 LIS professionals was invited, through email, to participate in the study, of which 123 completed the survey. Initial data screening identified only 116 questionnaires were valid. The other seven questionnaires were rejected based on duplication, unanswered, incomplete, and multiple answers. Hence, the rate of survey response was 77%. SPSS®22 and Amos®21 were used to analyze the collected data.

4 Results

4.1 Demographic Findings

Table 1 depicts the breakdown of the demographic characteristics of the respondents in detail. Results show that 84 (72.4 %) were male, and most of them working in the public sector 81 (69.8%) universities of the Punjab, Pakistan. In terms of academic qualification, most of the

respondents have a master's degree in Library & Information Science 74 (63.8 %). Moreover, most LIS professionals, 44 (37.9 %), had 11-15 years of work experience.

Table 1: Demographic Profile of Respondents

Demography	Description	No.of Responses	%
University Type	Public	81	69.8
	Private	35	30.2
Gender	Male	84	72.4
	Female	32	27.6
Age	< 30 Year	28	24.1
	31-40 Year	36	29.3
	41-50 Year	15	32.8
	51-60 Year	6	13.8
Qualification	MLISc	74	63.8
	M Phil	41	35.3
	PhD	1	0.9
Professional Experience	< 5 Year	23	19.8
	6-10 Year	33	28.4
	11-15 Year	44	37.9
	16-20 Year	9	7.8
	> 20 Year	7	6.0

4.2 Construct Reliability

To check the reliability Cronbach's alpha of both constructs was calculated. Table 2 revealed that Cronbach's alpha coefficient for both constructs technostress ($\alpha = .847$) resistance to technology adoption was ($\alpha = .796$) surpassed the cut off value of 0.7. This study employed factor loading, composite reliability (CR), and average variance extracted (AVE). Hair et al. (2010) suggested the standardized factor loading should be 0.5 and preferably 0.7 or higher, While CR should not be less than 0.7, indicating that all the requirements are fully met.

Table 2: Constructs reliability, Cronbach's alpha, Composite reliability, and AV

Construct	Item	Loadings	Cronbach's alpha	Composite reliability	Average variance extracted
Technostress	TE1	0.796	0.847	0.858	0.749
	TE2	0.794			
	TE3	0.749			
	TE4	0.703			
	TE5	0.659			
	TE6	0.596			
Resistance to Technology Adoption	RT1	0.543	0.796	0.854	0.786
	RT2	0.635			
	RT3	0.831			
	RT4	0.637			
	RT5	0.734			
	RT6	0.923			
	RT7	0.808			
	RT8	0.66			
	RT9	0.541			

4.3 Assessment of Overall Model Fit

Structural equation modeling requires that the developed measurement model meet some fit criteria (Hair et al., 2010). After examining individual construct, appropriate indices were used to measure the model fitness and as depicted in Table 3, all the fit criteria were fulfilled in the measurement model.

Table 3: Goodness Fit Model

Fit Indices	Standard	Test Result	Remarks
chi-square	< 5	.1962	Supported
Goodness-of-Fit Index	>.90	.910	Supported
Incremental Fit Index	>.90	.959	Supported
Tucker-Lewis Index	>.90	.946	Supported
Comparative Fit Index	>.90	.959	Supported
Root mean square error of approximation	< .08	.064	Supported

Amos subsequently provided estimated results of the hypothesis based on empirical data from the respondents. The association between the dependent and independent variables was observed and found that the path significant, with a strong positive association among the variables tested for the validation of the research hypothesis. The R^2 value for the association between predictor and outcome variable is 0.564, indicating that 56.4 percent of the variance in resistance to technological change is explained by technostress. The p-value of the tested hypothesis is less than 0.05, technostress (TE) has a significant association with RT at ($p > .05$, beta = -0.338). Therefore, the hypothesis is reinforced: technostress impacts the resistance to the adoption of technology in the university libraries, which is, according to the findings of Sweeney & Summers, (2002) explored how technology affected management issues, personnel change, stress source. Similarly, Tarafdar et al. (2007) discovered that workers face technostress while using technology in their workplace. The result of the study is also consistent with the previous research.

5 Conclusion

It is concluded from the findings of this study and review of literature that there exists a positive relationship between resistance to adoption of technology in the university libraries to technostress. The most significant reason for technostress was the use of new technological tools in the library, making the job harder, and handling technologies. In this study, it was discovered that the prevalence of technostress among male respondents working in the public sector university libraries was slightly high. Most of them worked in the public sector universities of Punjab, Pakistan.

In the vein of this research results, older people have more resistance. Most likely, the reason for this is that the respondents are senior LIS professionals working in Pakistan's public sector university libraries. The respondents who have apprehension or anxiety about the usage of computers and other technologies would more likely to resist. This will help the individuals be more conversant with using the relevant technology and predispose them to experience technostress. These will help to increase productivity and reduce stress.

6 Availability of Data and Material

Information can be made available by contacting the corresponding author.

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Abida Hanif is a Doctoral student at the Department of Library & Information Science, The Islamia University of Bahawalpur, Pakistan, and serving as an in-charge librarian at COMSATS University Islamabad, Vehari campus. She is a life member of the Pakistan Library Association (PLA) and Pakistan Library Club, Coordinator LISolutions-South Punjab, Coordinator ILAP-South Punjab.



Dr. Salman Bin Naeem is an Assistant Professor at the Department of Library & Information Science, The Islamia University of Bahawalpur, Pakistan. He holds a Ph.D. in Library & Information Science and has a specialization in the field of Health Information Outreach. He conducted research studies on 'fake news' and 'News Literacy', as a part of his postdoctoral fellowship. He was an awardee of the ASIS&T Best Paper Award 2018, ASIS&T InfoShare Award 2020, ASIS&T Annual Meeting Attendance Scholarship Award 2020.



Professor Dr. Rubina Bhatti is Chairperson at the Department of Library & Information Science, the Islamia University of Bahawalpur, Pakistan. She got a PhD from the UK. Her research interests encompass Management, Marketing, Information Literacy, Library Anxiety, Academic Libraries, Research Methodology, Public Libraries, Digital Libraries, Health Information Outreach



Traffic Simulation Analysis for Depot Construction Period of Bangkok–Nakhon Ratchasima High-Speed Train

Juraluk Thinphowong¹, Boonsap Witchayangkoon^{1*}, Winai Raksuntorn¹,
Sayan Sirimontree¹, Sanya Namee², Ahmad Sanusi Hassan³, Yasser Arab³

¹ Department of Civil Engineering, Thammasat School of Engineering, Thammasat University, THAILAND.

² Department of Disaster Prevention and Mitigation, Ministry Of Interior, Royal Thai Government, THAILAND.

³ School of Housing, Building and Planning, Universiti Sains Malaysia, Penang, MALAYSIA.

*Corresponding Author (Email: Drboonsap @ gmail.com).

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Abstract

Thailand plans to build the Bangkok–Nong Khai (Northeastern) High-Speed Railway as part of the Kunming–Singapore railway central section, using dual standard-gauge tracks and operating speed 250 km/h. The first part is the Bangkok–Nakhon Ratchasima High-Speed Railway. This study conducts the traffic simulation analysis for traffic management inside the depot construction site of Bangkok–Nakhon Ratchasima High-Speed Railway Depot Project. Using Aimsun software with microscopic traffic simulation modeling, this study models a total of five options and compares the results under a traffic management plan to alleviate the difficulty of traffic control task of 700 vehicles per day carrying materials to deliver inside the construction project site. Delivery materials include spun piles, landfill materials, ready-mix concrete, and machinery and service vehicles. This study reveals that the construction site traffic depends on volume to road capacity ratio, volume to unloading time ratio, vehicle-time schedule, and limited stopping area. From the analysis, the best solution is to divide the traffic volume into two periods a day to distribute the volume of traffic inside the depot construction project, as the total travel times and delays are decreased and cause no effect on the public traffic system. The operating cost is also the lowest.

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1. Introduction

Thai Government initiates to build the Bangkok–Nong Khai (Northeastern) high-speed railway (608 km) as part of the Kunming–Singapore railway central section, using dual standard-gauge tracks and operating speed 250 km/h. The construction for the first portion is the Bangkok–Nakhon Ratchasima high-speed rail line (253 km, worth 176,600 million Baht (5900 million USD), estimated 14700 passengers per day, EIRR 14.9%).

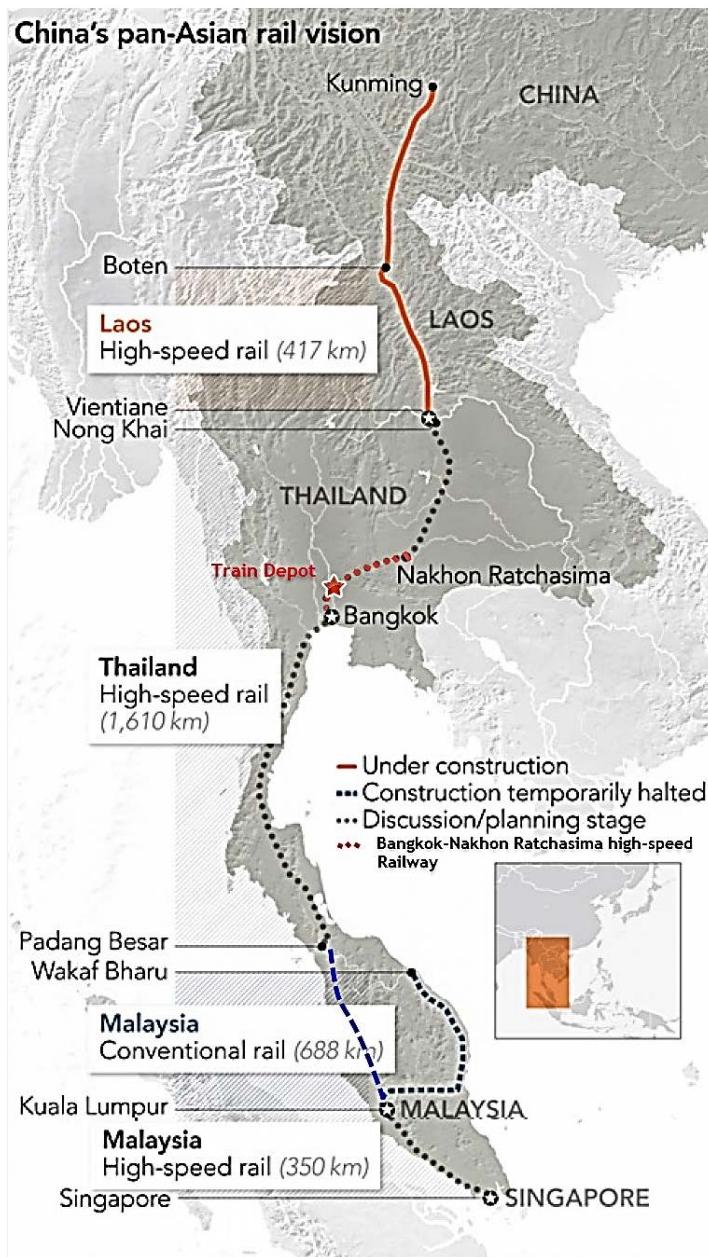


Figure 1: Kunming–Singapore railway central section (original image courtesy of Nikkei Asian Review).

1.1 High-speed Train Depot

High-speed train depot (Figure 2) provides train standard services and supports for the service and maintenance works of the trains in the depot. The Bangkok-Nakhon Ratchasima high-speed railway depot is a megaproject in Thailand worth 7764 million Baht (260 million USD). The depot construction comprises landfill up to the level of rail, 41 maintenance, training, and office buildings, road, drainage, and other infrastructure systems.

The main works of this depot construction project consist of earthwork, civil and structural work, architectural work, and building service work. Since this project must be finished within 36 months as per contract agreement, the traffic volume of material transportation, at the peak time of construction period, as per construction plan is 700 vehicles per day. Therefore, the traffic volume at the peak period is very high, so the traffic management plan is required for this project.



Figure 2: High-speed train depot model.

2. Literature Review

Most traffic studies involve normal urban road traffic management (e.g. Kantonon et al. (2018), Pananun et al. (2018)).

Khanta (2008) evaluated the capabilities of traffic simulation model software packages and gave recommendations in selecting the appropriate simulation package for a particular work project.

Zou et al. (2012) analyzed traffic impacts of urban construction projects using traffic simulation based on surveys and analysis of the traffic information. The study suggested distribution reasonably the traffic volume to the balance of the project. In addition, they applied an integrated assessment impact index calculation method and evaluation, to reinforce the traffic management for the construction projects.

Yang et al. (2012) reported the traffic impact simulation study for road construction projects in China, using Vissim software. The traffic impact assessment was beneficial for traffic policy and management especially in terms of traffic flow guide, signal adjustment, spot management, signs replacement, and facilities resetting.

Hammad (2020) studied construction site layout planning problems based on location and traffic assignment models, optimized for multi-objective purposes. The consideration for location and traffic decisions ensures effective operations for the construction stages and enhances on-site traffic management.

This work models traffic flow within the construction site, to analyze and manage traffic during construction of large depot Bangkok–Nakhon Ratchasima High-Speed Train.

3. Train Depot Site Details

Bangkok-Nakhon Ratchasima High-Speed Railway Depot, contract 4-4, is part of a mega project of the State Railway of Thailand (SRT). The north side of this project is connected with Motorway No. 9. This depot construction project area is 500,000 square meters located at Chiang Rak-Noi (geolocation 14.150571356878872, 100.58012701535907), see Figure 3.

4. Method

4.1 Delivery of Construction Materials

To construct the depot, it is required to plan the traffic management of the construction site, under constraints that all the construction must be finished within 36 months. For the depot site landfill, it is planned that 625 dump trucks daily deliver dirt to fill the site, and after compaction has the level of the rail. The depot will have 41 buildings and needs totaling 110,000 piles. It is estimated that 35 trailer trucks per day come to the site for concrete pile delivery. It is expected that 30 ready-mix concrete trucks a day enter the site for fresh concrete delivery. It is estimated that the site will have 10 machinery and service vehicles per day. Table 1 gives detail of the delivered materials to be and the daily number of vehicles entering the construction site.

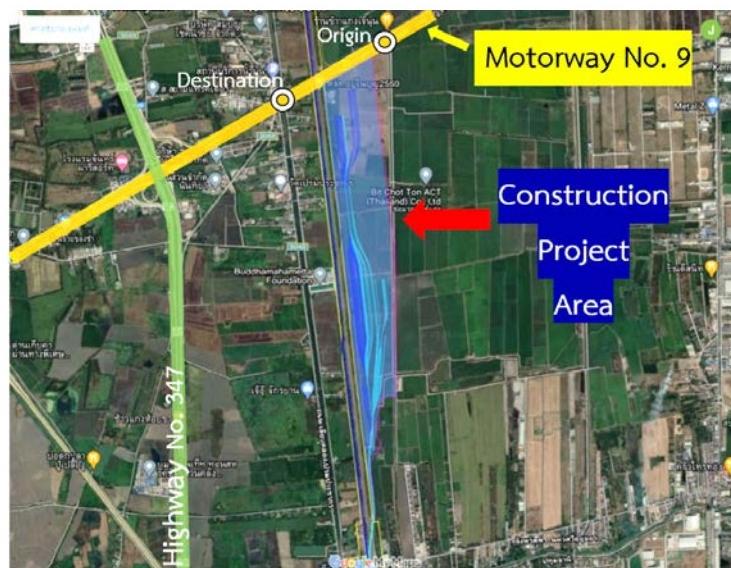


Figure 3: Bangkok-Nakhon Ratchasima high-speed railway depot position and dimensions.
(Courtesy of Google map)

Table 1: Materials to be delivered to the construction site and the daily number of vehicles.

Materials	Specification	Total Amount	Number of vehicles sending materials/services into the construction site (vehicles/day)
Spun Piles	40cm diameter, 9mm thickness, 18m long	110000 piles	35
Landfill materials	Following the engineering specification	2.5million m ³	625
		70000 m ³	30
Machinery and service vehicles	Per requests	Per requests	10
		Total	700

4.2 Characteristic and Conditions of Vehicles

For each type of delivered material, the characteristics and conditions of vehicles are important for modeling. Table 2 shows speed constrain, estimated time for unloading material, and deviation unloading time for each type of vehicle.

Table 2: Vehicle constrain.

Materials	Type of Vehicle	Speed limit (km/hr)	Material unloaded time (seconds)	Deviation in unloading time (seconds)
Spun Piles	Open trailer truck (25m long)	20	3600	900
Landfill materials	Dump truck	20	300	60
Ready-mix Concrete	Ready-mix concrete truck	20	900	300
Machinery and service vehicles	Service truck	20	-	-

4.3 Traffic Simulation Options

This study investigates traffic conditions according to traffic management plans based on five options (Table 3) that have been established by the authors of possible traffic flow in the construction site. This study uses Aimsun, a traffic simulation software, is utilized to model each option and analyze and determine the suitable traffic management plan use for this project before the work started. Besides, traffic management costs can be estimated accurately. The temporary service road in the site is one-way 15km long, comprising a 6km main road, and 9km sub-roads.

Table 3: Simulation option of daily traffic management inside the construction site.

Option	Number of traffic lanes inside the site (one-way)	Allowed number of vehicles per working area	Distance from the origin point to the destination	Number of working periods per day	Simulated working hours (hr/day)
1	1	1	Nearest distance	1	10
2	1	3	Nearest distance	1	10
3	1+ 1 additional lane for the distances 3km	3	Nearest distance	1	10
4	1+ 1 additional lane for the distances 3km	3	Re-route for a longer distance for dump trucks	1	10
5	1	3	Nearest distance	2	10+10

Table 2, the nearest distance is the shortest distance from origin passing the unloading point and go out to the destination. Inside the project, the temporary service road will be established to support construction work such as material transportation work, equipment mobilization, and other services. The route line of the temporary service road is depended on traffic management plan options. For all options, the vehicles will start from the origin point and go to the destination point on the public road out of the project area as shown in Figure 3.

4.4 Aimsun Modeling and Simulation of Traffic Condition

Aimsun microscopic traffic simulation models can represent the traffic condition under the assumption of efficiency. In this study, five options of the traffic management plan have been set

up for the analysis. In the Aimsun microscopic traffic simulation modeling environment, the input data include the number of lanes, speed limit, vehicle-time schedule, material unloading area, stopping time at unloading area, and vehicle travel route. The origin point and destination point are on the public road outside the construction project area. The detectors have been placed on the road at the joint between project road and public road for the count the number of vehicles entering and exiting the project.

5. Simulated Results and Discussion

Table 3 gives the analysis detail of each option including start work and finish work. The total travel time is the sum of time of each vehicle counted from the origin point to the destination point, including the traffic time and materials' unloading time.

For each option, the Aimsun models give serious traffic impact on the construction site. In Figure 4, The red dots and the red lines indicate problematic traffic conditions. The bigger the dot, the more traffic problem occurs. The dark lines represent an additional lane is added to the roads. From the simulated results Table 3 and Figure 4, it can be seen that option 1 the work cannot get all finish. option 5 gives the lowest total travel time and the least traffic problem. Also, the workers' overtime cost is the lowest for option 5. This also can save the operating cost of the vehicles.

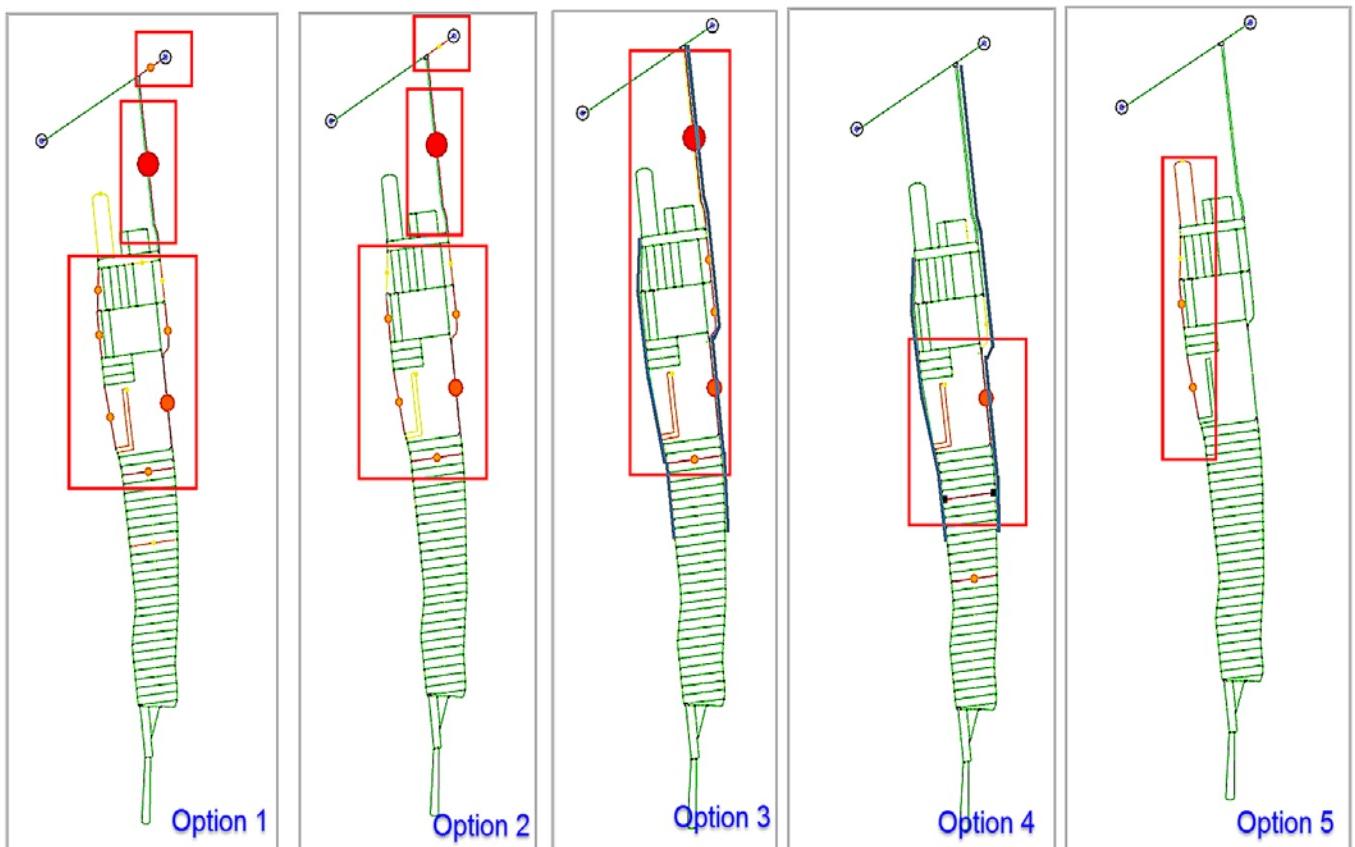


Figure 4: Result from the Aimsun analysis.

Table 3: Detail and result of the analysis.

Option	Start work	Finish work	Total travel time (hr)	Staff working overtime (count after 10hr working time) (hr/staff)	Traffic impact on the public road
1	7 AM	Not Finish	2103.2	14	YES
2	7 AM	11 PM	1458.9	6	YES
3	7 AM	10 PM	1427.5	5	NO
4	7 AM	10 PM	1365.2	5	NO
5	Period 1	7 AM	6 PM	1155.6	NO
	Period 2	6 PM	5 AM		NO

6. Conclusion

This research simulates and analyzes the traffic of vehicles delivering construction materials to the construction site to build the depot of the Bangkok-Nakhon Ratchasima High-Speed Train project in Thailand. It is estimated that construction materials are delivered daily by 700 vehicles including open trailer trucks, dump trucks, ready-mix concrete trucks, and service trucks. A total of five options has been simulated under different construction and traffic constraints. Using the Aimsun modeling software with microscopic traffic simulation modeling, the simulation results show that the option 5 model consisting of two periods gives the best solution with the least operating cost and produces no effect to the public traffic system. This study shows that the construction site traffic depends on volume-to-road capacity ratio, volume-to-unloading time ratio, vehicle-time schedule, and limited stopping area.

7. Availability of Data, and Material

Data can be made available by contacting the corresponding author.

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Juraluk Thinphowong is a Master's degree student at the Department of Civil Engineering, Thammasat School of Engineering, Thailand. She received a Bachelor of Engineering in Civil Engineering and Management from Thammasat University. Her interests involve Construction Project Management and Traffic Control and Management.



Dr. Boonsap Witchayangkoon is an Associate Professor in the Department of Civil Engineering at Thammasat University. He received his B.Eng. from the King Mongkut's University of Technology Thonburi with Honors. He continued his PhD study at the University of Maine, USA, where he obtained his PhD in Spatial Information Science & Engineering. Dr. Witchayangkoon interests involve Applications of Multidisciplinary and Emerging Technologies to Engineering.



Dr. Winai Raksuntorn received his PhD (Civil Engineering) from the University of Colorado, USA. He is currently an Assistant Professor in the Department of Civil Engineering, Faculty of Engineering, Thammasat University. His research interests include Transportation Safety Analysis, Traffic Operations, and Management, Traffic Impact Studies, Traffic Flow Modeling, Highway Capacity Analysis, Advanced Traffic Management for Intelligent Transportation Systems.



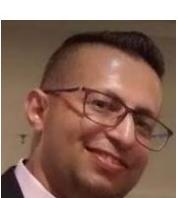
Dr. Sayan Sirimontree earned his bachelor's degree from Khonkaen University Thailand, master's degree in Structural Engineering from Chulalongkorn University Thailand, and Ph.D. in Structural Engineering from Khonkaen University Thailand. He is an Associate Professor at Thammasat University Thailand. He is interested in the Durability of Concrete, Repair, and Strengthening of Reinforced and Prestressed Concrete Structures.



Dr. Sanya Namee works at the Department of Disaster Prevention and Mitigation, Ministry of Interior, Thailand. He holds a Bachelor of Engineering from King Mongkut's Institute of Technology Ladkrabang, a Master of Engineering degree from Prince of Songkhla University and a Ph.D. degree in Civil Engineering from Thammasat University, Thailand. His research interests encompass Hazardous Material Transport.



Professor Dr. Ahmad Sanusi Hassan teaches at Architecture Programme, the School of Housing, Building and Planning, Universiti Sains Malaysia (USM), Penang, Malaysia. He obtained a Bachelor and Master of Architecture degrees from the University of Houston, Texas, the USA, and a Doctor of Philosophy (PhD) degree from the University of Nottingham, UK. His research focuses on Sustainable Architecture and Urban Design Development for Southeast Asia, history and theory of Architecture, Computer-Aided Design (CAD), and Computer Animation.



Dr. Yasser Arab is a Senior Lecturer at Universiti Sains Malaysia. He obtained his Bachelor of Architecture from Ittihad Private University, Aleppo, Syria. He obtained a PhD in Sustainable Architecture from Universiti Sains Malaysia (USM), Penang, Malaysia. His research focused on the Environment Performance of Residential High-Rise Buildings' Façade in Malaysia.



Drivers of ICT Adoption in Small and Very Small Businesses in Technologically Least Developed District of Southern Punjab

Raheel Nawaz ^{1*}, Khuda Bakhsh, Sami Ullah ¹, Sana-ur-Rehman ²,
Muhammad Azeem ^{3*}, Aamir Hayat ³

¹ Department of Management Sciences, COMSATS University Islamabad, Vehari Campus, PAKISTAN.

² Department of Business Administration, NFC Institute of Engineering and Technology, Multan, PAKISTAN.

³ Department of Management Sciences, COMSATS University Islamabad, Vehari Campus, PAKISTAN.

*Corresponding Author (Email: pheavhr@gmail.com, muhammadazeem.ch25@gmail.com).

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ICT intentions; ICT infrastructure; E-sales; Human capital; SMEs; Internet integration; E-procurement; ICT adoption; Technological competencies.

Abstract

The study examines the extent of ICT adoption and to determine the effects of technological competencies and human capital on the adoption of ICT among small and medium enterprises (SMEs) in Southern Punjab, Pakistan. We collected cross-sectional data from 170 firms. The ordered probit model was employed. ICT adoption includes ICT intentions, ICT infrastructure, internet integration, e-sales, and e-procurement. Results showed that research collaboration was the only variable having a significant and positive effect on all ICT adoption measures. This implied that investment in research collaboration by the firms could lead to an increase in ICT adoption. The study also found that research and development were significantly related to ICT infrastructure, e-sales, and e-procurement. Results also suggest that the firms need to enhance their R&D activities, innovations, and research collaborations to increase their ICT intentions. The latter two should also be emphasized to promote internet integration in firms.

Disciplinary: Business Management (SME) and Information Technology.

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1. Introduction

The performance of organizations and businesses has improved as a result of the adoption of the advancement in data and telecommunication as compared to the manual systems (Shiels et al., 2003). In the presence of a competitive market environment, very small and small businesses are making arrangements for ICT adoption to contend with the rivals and attract customers. Key factors of ICT adoption among SMEs include structure innovation, analysis and development activities, analysis collaboration, personnel with ICT skills, and decentralized decision-making process. Such factors have greater implications for the very small and small businesses operating in a dynamic atmosphere. Some of the benefits of ICT adoption include a reduction in operation prices, an increase in client satisfaction, and market share, and an improvement in employee performance (Buhalis & Main, 1998; Karadag et al., 2009). The adoption of ICT helps businesses to enhance business activities expeditiously and effectively. Some examples include storing, dispensing, spreading, communication, retaining of data (Ongori & Migiro, 2010), addressing challenges of dynamic atmosphere and operation efficiency (Spanos et al., 2002).

Adoption of ICT in very small and small businesses is associated with changes in price effective production, firm potency, effective chain management, and sound business opportunities (Fulantelli & Allegra, 2003; Ghobakhloo et al., 2011; Ongori & Migiro, 2010). Now the question arises what are possible barriers hindering ICT adoption among the very small and small businesses. The required investment, motivation, and lack of trained staff, obtaining license, amendment in the business surroundings, and infrastructure at the firm level are cited as possible barriers to ICT adoption (Ghobakhloo et al., 2011; Tan et al., 2010). Such problems become more prevalent in developing countries where there is limited availability of skilled and trained personnel and small family firms dominate.

Very small and small businesses in Pakistan like other developing countries are facing challenges of ever-increasing competition as the world has become a global village in the present era. For surviving in a dynamic competitive environment, businesses have started diverting attention towards the adoption of ICT to provide e-services and enhance production and productivity. Further, ICT adoption heavily depends on economic and political stability (Amit and Zott (2001) because the businesses need huge initial investment for infrastructure, culture diversity, and entrepreneurial activity (Erumban & De Jong, 2006). Despite fiber cable reaching the least developed countries (Kilangi, 2012), ICT acceptance and its application in developing countries is further restricted only to email services and websites (Goldstein and O'connor (2000). Houghton and Winklhofer (2004) argue that acceptance of ICT by SMEs is still in the infancy stage in developing countries. Kapurubandara and Lawson (2006) cited internal and external barriers to the introduction of ICT in SMEs. Internal barriers include proprietary manager characteristics, strong performance, and value for money. Infrastructure, social, cultural, political, and legal aspects are considered as external factors.

Pakistan presents a typical case for the adoption of ICT by very small and small businesses. These businesses dominate the economy with limited human capital and technological competencies. Further, businesses are mostly managed and operated by family members. Such businesses can survive in the rising competitive environment by adopting new technologies. One finds huge literature on ICT adoption in developed countries. We find very limited research work on ICT adoption and its determinants among very small and small businesses operating in developing countries. Traditional, cultural values and capital of the businesses in developing countries are hugely different from those of developed nations. The present study is designed to see the extent of ICT adoption among very small and small businesses and the effects of firm and firm-owner-related characteristics on the extent of ICT adoption in the less developed part of Southern Punjab,

Pakistan. The importance of this study lies in the fact that small enterprises can gain a competitive advantage through ICT adoption. Findings would also be useful for the government officials and SMEs policymakers to develop the strategies and sustainability of SMEs. We measured the role of the firm competencies and workforce capacity in ICT adoption. Five dimensions are considered including ICT intentions, ICT infrastructure, E-sales, E-procurement, and integration.

The study is based on the technology adoption model. This model is widely used in studying adoption factors affecting ICT (Shaikh & Karjaluoto, 2015). Technological competencies and the human capital of firms are important in ICT adoption. Technological competencies include organizational innovations, research and development activities, and research collaboration. Organizational innovation means examining and analyzing ICT innovation, resources owned by firms, and the effects of ICT on firms (Brynjolfsson & Saunders, 2010; Hammer & Champy, 1993; Lyytinen & Newman, 2008). Organizational innovation provides firms an edge against competing firms in the market as a result of efficient management of production processes, service provision, and feedback from the users of the services and or products. Similarly, research and development activities enable firms in adopting new technologies and this is true for ICT use in production processes. Research and development activities tend to produce innovations, improving firms' capability to isolate, integrate, and expand activities to a wider level. Further research and development activities foster opportunities for a variety of learning instead of learning by doing. Research collaboration is another important component of technological competencies with an important role in ICT adoption. Bjerregaard (2010) argued that cultural variation and communication could hamper the general production of information about knowledge data and cooperation. The importance of collaboration needs to be boosted in the area of personal information management. Research collaboration can provide improved variation of capital, abilities, information, and perspectives (Hannigan & Curran, 2008). As noted by (Giopoulos et al., 2017), there exists a positive relationship between technological competencies and ICT adoption. Thus, the first hypothesis of the study is

H#1: A firm's technological competency is positively associated with ICT adoption.

Another aspect of the study is the effect of human capital on ICT adoption among SMEs. Human capital includes personnel with scientific background and personnel with ICT skills. Firms with highly scientific personnel are highly probable to possess a higher level of technology (Bartel & Sicherman, 1999). Personnel with scientific skills promote the use and adoption of ICT in the organization (Arvanitis, 2005; Bayo-Moriones & Lera-López, 2007; Fabiani et al., 2005). Similarly, firms with personnel having ICT skills have a greater tendency of ICT adoption. Bharadwaj (2000) showed that firms having permanent ICT employees have a competitive edge over other firms through turnover and cost-established procedures and realizing the economic benefits of ICT adoption. Thus, we assume that human capital entrenched in the employees of SMEs has a significant impact on the adoption procedure and exploitation of ICT. Based on these facts, our second hypothesis is

H#2: A skilled workforce with a scientific background is positively associated with ICT adoption.

2. Material and Methods

2.1 Data and Source

This study is different from the previous studies because those studies were conducted in developed countries. Development level, infrastructure, human capital, organizational competencies, tradition, and customs in the developed countries are substantially different and are present in improved and advanced form compared to the developing countries. Further, the present

study has focused on the southern part of Punjab province of Pakistan and this part of Pakistan is least developed compared to northern and central Punjab of Pakistan.

This study purposively selected Vehari District of southern Punjab. Vehari is characterized by dominant agro-based industries. Vehari chamber of commerce and industry (VCCI), established a few years ago, is making efforts to boost business activities in the district through providing training to small entrepreneurs and building contacts of small entrepreneurs with established chambers of commerce and industry in the province to provide exposure to successful businesses. A total of 315 firms are registered with VCCI. From the obtained list of business firms registered with VCCI, 175 very small and small firms were selected randomly.

Well-prepared and pre-tested questionnaires were used. Each variable contained a different number of items. The items were close-ended questions with options for the managers and owners of very small and small businesses to choose as many options as were applicable. The cross-sectional data were collected through a structured questionnaire divided into four sections namely the firm's internal industry, human capital, and use of ICT and innovation activities. We received 170 questionnaires completed in all the respects, giving a response rate of 97%.

2.2 Empirical Methods

Descriptive statistics are used to examine the characteristics of the selected firms. In ICT adoption, we considered ICT intentions, ICT infrastructure, internet integration, E-sales, and E-procurement. By ICT intentions, we mean the degree to which the firm has applied or proposes to apply activities required for starting ICT. ICT infrastructure shows the number of ICT assets possessed by SMEs. ICT assets comprise information on resource management system, information systems manager, computer room, and security back up plan for information systems. The amount of a firm's resources that are maintained by the application of the Internet is known as internet integration. This variable explains the number of tasks performed by using the Internet. E-sales variable is defined as the ratio of on-line selling to the total turnover. E-procurement is the proportion of electric earning to entire earning. Likert scale was used to obtain information from the respondents. Since the response is in ordered form, we employed an ordered probit model to examine the effect of technological competencies, human capital, and control variables on ICT adoption. Five ordered probit models were run one for each ICT adoption measure.

Equation (1) was used for ICT acceptance.

$$\text{ICT Adoption} = \beta_1 \text{TechComp}_i + \beta_2 \text{HumCap}_i + \beta_3 Z_i + \varepsilon_i \quad (1).$$

TechComp_i shows the technological competencies of the selected firms, HumCap_i denotes the human capital features of the selected SMEs, Z_i represents control variables and ε_i is the random error term assumed to be normally distributed. β_1 , β_2 , and, β_3 denote the marginal effects of variables to be estimated.

3. Results and Discussion

Table 1, 170 firms were surveyed; only 18.2% of firms are in manufacturing industries. Of these, 6.4% belong to the very small business size category, whereas 32.9% of them are from the small business size category. Merely 29.4% of firms are in services industries. Of these, 39.4% belong to the very small business size category, whereas 17.1% of them are from the small business size category. 52.4% of firms are in the trading industries. Of these, 54.3% belong to the very small business size category, where 50% of them are the small business size category. The majority of the firms were 5-15 years old. Around 79% of very small firms were located in Vehari city while 63% of small businesses were doing business activities outside Vehari city.

Table 1: Summary statistics.

Firm Size	Very small Business	Small Business	Total
Firm industry			
Manufacturing	6 (6.4)	25 (32.9)	31 (18.2)
Services	37 (39.4)	13 (17.1)	50 (29.4)
Trading	51 (54.3)	38 (50)	89 (52.4)
Firm location			
Vehari city	74 (78.7)	28 (36.8)	102 (60)
Outside Vehari city	20 (21.3)	48 (63.2)	68 (40)
Distance from Vehari			
Less than 5 km	5 (25)	5 (10.4)	10 (14.7)
5 to 15 km	6 (30)	16 (33.3)	22 (32.4)
16 to 30 km	3 (15)	10 (20.8)	13 (19.1)
More than 30 km	3 (30)	17 (35.4)	23 (33.8)
Firm age			
Less than 5 years	15 (16)	7 (9.2)	22 (12.9)
5 to 15 years	47 (50)	38 (50)	85 (50)
16 to 30 years	29 (30.9)	26 (34.2)	55 (32.4)
More than 30 years	3 (3.2)	5 (6.6)	8 (4.7)

Note: Figures in parentheses are percentages

Table 2 provides information on ICT adoption. We found that firms do not attempt to adopt new ICTs were 26.5%. 30.9% of such firms were from very small business size type, whereas 21.1% of firms were small business size type. Merely 48.2% of firms carried out limited efforts to adopt new ICTs. Only 20% of firms were found undertaking significant efforts to adopt new ICTs. Of these, 16% were very small business size type and 25% small business size category. Only 5.3% of firms adopted new ICTs immediately prior to competitors. Considering the integrated resource management information system, only 11.9% of firms were found with integrated resource management information systems out of 170 firms. Of these, 8.51% were very small business firms, and 21.1% small businesses. Merely 8.5% of firms had the services of a dedicated information system manager. Out of the total firms surveyed, only 34.3% of firms were found to have a computer room. While the very small firm and small firms with computer rooms were 33% and 50% respectively. The respective percentage of installed information system security and risk assurance plan was 16% and 39.5%. Very small and small firms with no ICT infrastructure were 36.2% and 15.8% respectively. The percentage of the firms using the Internet for finding the information was only 41.1% and 32.3% of firms using the Internet for e-mail. Only 7% of the total selected firms used the internet for banking transactions. The firms using the Internet for ordering was only 9.2% whereas 10.4% of firms had no internet integration. Of the surveyed 170 firms, 82.9% firms were

found not selling products through Internet, 82.9% firms did not place orders via the Internet and this percentage was higher for very small business firms (Table 2).

Table 2: Description of firms with regard to ICT adoption

Firm Size	Very small Business	Small Business	Total
ICT intentions			
To what extent the firm has an orientation to adopt new ICTs?			
There is no attempt	29 (30.9)	16 (21.1)	45 (27)
Limited efforts	47 (50)	35 (46.1)	82 (48)
Significant efforts	15 (16)	19 (25)	34 (20)
Immediately prior to competitors	3 (3.2)	6 (7.9)	9 (5)
ICT infrastructure			
To what extent the ICT resource has been installed by the firm?			
Integrated resources management information	8 (8.51)	16 (21.1)	24 (12)
Information system manager	3 (3.2)	14 (18.4)	17 (9)
Computer room	31 (33)	38 (50)	69 (34)
Information system security & risk assurance	15 (16)	30 (39.5)	45 (22)
None	34 (36.2)	12 (15.8)	46 (23)
Internet integration			
In how many business functions the firm makes use of the internet?			
Finding information	67 (71.3)	63 (82.9)	130 (41)
E-mail	49 (52.1)	53 (69.7)	102 (32)
Banking transactions	12 (12.8)	10 (13.2)	22 (7.0)
Conduct of ordering	14 (14.9)	15 (19.7)	29 (9.2)
None	22 (23.4)	11 (14.5)	33 (10)
E-sales			
To what extent the company sells products through the internet?			
0%	87 (92.6)	54 (71.1)	141 (83)
1% - 30%	3 (3.2)	12 (15.8)	15 (8.8)
31% - 60%	3 (3.2)	5 (6.6)	8 (4.7)
61% - 100%	1 (1.1)	5 (6.6)	6 (3.5)
E-procurement			
To what extent the company sets orders via the internet?			
0%	83 (88.3)	58 (76.3)	141 (83)
1% - 30%	7 (7.4)	9 (11.8)	16 (9)
31% - 60%	3 (3.2)	6 (7.9)	9 (5)
61% - 100%	1 (1.1)	3 (3.9)	4 (2)

Note: Figures in parentheses are percentages

3.1 Determinants of ICT adoption

Table 3 shows the estimates of the ordered Logit model. We found that organizational innovations and R&D activities had a positive and significant effect on the probability of ICT intentions. Research collaborations variable was also positive and significantly related to ICT intentions. These results are consistent with the previous studies (Alshamaila, et al., 2013; Arvanitis & Hollenstein, 2001; Giotopoulos et al., 2017; Hollenstein, 2004). Personnel with scientific background variables were insignificant for ICT intentions, whereas personnel with ICT skills were negative and significant. This seems surprising. However, one possible explanation for these results is brought forward by Macgregor and McCulloch (2006) that small businesses are unwilling to adopt ICT because they consider it complex. Firm size was negative and significant. Higher the firm size, the lower the probability of ICT intentions. Bayo-Moriones and Lera-López (2007) also found that firm size negatively affects ICT adoption. Irefin, et al., (2012) found the same relationship as well. Firms involved in the services sector were found with lower ICT intentions compared to firms in the manufacturing sector. Firm location negatively and significantly affected the ICT intentions of the firms.

Considering ICT infrastructure, we found that organizational innovation was negatively related to ICT infrastructure and statistically different from zero. This finding is in agreement with Rowe, et al., (2012). The coefficient of research collaborations was positive and statistically significant. Giunta and Trivieri (2007) also found a positive effect of research collaboration on ICT adoption. Firms in the services and trading sectors were found to have a higher probability of possessing ICT infrastructure than the firms in the manufacturing sector (Table 3).

Table 3: Results of the marginal effects of the ordered Logit Model.

	ICT intentions	ICT infrastructure	Internet integration	E-sales	E-procurement
Firm Size	-0.47* (0.24)	0.43 (0.31)	0.19 (0.23)	0.54* (0.33)	0.20 (0.38)
Service	-0.74* (0.35)	1.38* (0.53)	0.05 (0.33)	-0.73 (0.48)	5.51 (327.35)
Trading	-0.43 (0.37)	1.04* (0.53)	-0.71* (0.33)	-0.71 (0.47)	5.34 (327.35)
Firm Location	-0.49* (0.25)	-0.18 (0.31)	-0.59* (0.24)	-0.40 (0.34)	-0.57 (0.36)
Firm Age	-0.13 (0.13)	-0.13 (0.17)	-0.20 (0.13)	-0.34* (0.20)	0.25 (0.20)
Organizational innovations	0.83* (0.12)	-0.30* (0.19)	0.44* (0.11)	0.04 (0.08)	0.15 (0.10)
R&D Activities	0.65* (0.17)	0.13 (0.22)	0.25 (0.16)	-0.02 (0.21)	-0.03 (0.27)
Research Collaborations	0.17* (0.08)	0.21* (0.09)	0.12* (0.07)	0.59* (0.17)	0.59* (0.18)
Personnel with scientific background	0.12 (0.10)	0.10 (0.15)	-0.22* (0.10)	0.12 (0.14)	-0.00 (0.16)
Personnel with ICT skills	-0.31* (0.10)	-0.22 (0.15)	-0.16* (0.09)	-0.32* (0.15)	-0.25 (0.16)
Log likelihood	-140.644	-71.5973	-157.664	-87.6422	-80.3898
LR chi ²	120.24	28.28	81.52	39.32	50.48
Number of observations	170	170	170	170	170

Notes: Standard errors are reported in parentheses, *Significant at the 10% level.

Variable namely research collaboration was found statistically different from zero and positively related to ICT internet integration. These results are consistent with many studies (Alshamaila et al., 2013; Arvanitis & Hollenstein, 2001; Giotopoulos et al., 2017; Hollenstein, 2004). Personnel with scientific background and personnel with ICT skills variables were negative and statistically significant. This seemingly appears unexpected. Though one likely reason for these consequences is taken forward by Macgregor and McCulloch (2006) who argue that small businesses are unwilling to adopt ICT because of assuming ICT as complex in nature. The location of firms was significantly and negatively associated with internet integration (Table 3). The plausible explanation for this phenomenon is that internet facilities are not available in the rural areas of the district Vehari. This result is supported by Giotopoulos et al. (2017) who found that firms located in the urban center are more likely with Internet integration.

Research collaboration, personnel with ICT skills, firm size, and firm age were statistically different from zero while considering e-sales (Table 3). The finding of research collaboration is in agreement with Giunta and Trivieri (2007) who find a positive influence of research collaboration on ICT adoption. Positively significantly related firm size with e-sales is supported by Giunta and Trivieri (2007) who find that large firm size increases the probability of ICT adoption. Rowe et al., (2012) also found a positive effect of the size of the enterprise on e-commerce adoption. Large businesses own more financial and human resources and are more mature there for such firms are more likely to adopt ICT than small businesses (Dutta and Coury 2002; Irefin et al., 2012). The negative coefficient of firm age implies that the higher age of the firms lowers the e-sales because

the experienced firms learn that their customers mainly from Vehari district do not use and order their purchases through Internet, therefore such firms shift their focus from e-sales.

Regarding e-procurement, we found that only research collaborations were significantly related and all other factors were not significant. This finding is in agreement with (Giunta and Trivieri 2007). For the least developed district such as Vehari, e-procurement is not popular among the firms mainly due to following dominantly traditional practices, lack of awareness, and absence of ICT infrastructure

4. Conclusion

This study examines the extent of ICT adoption and to check the impact of technological competencies and human capital on the adoption of ICT among Vehari 170 SMEs, empirically analyzed through an ordered probit model which highlights the significance of observed aspects for ICT adoption by SMEs. From the findings, H#1 was supported whereas H#2 was not supported. However, the probability of ICT adoption is greater in those SMEs which are involved in R&D, innovation activities, and research collaboration. Firm size, firm age, firm location, and firm industry were used as control variables. The study results suggested that the extent of ICT adoption was low among Vehari SMEs. Organizational innovation positively affected ICT intentions and internet integration, whereas its effects on ICT infrastructure were negative. As e-sales and e-procurement were concerned, the impact of organizational innovation on these two was statistically insignificant. R&D activities only affected ICT intentions positively and remained insignificant in all other models. Findings also revealed that research collaboration was found to have a significant positive effect on all the sub-variables of ICT adoption thus research collaboration positively influences ICT adoption. Personnel with scientific background only negatively impact Internet integration whereas it was insignificant in all other models. Personnel with ICT skills have a negative impact on ICT intentions, Internet integration, and e-sales. However, its effects on ICT infrastructure and e-procurement were insignificant. In reality, the maximum of the SMEs has a deficiency of time, knowledge, and expertise to efficiently employ e-business strategy supporting agendas, meanwhile very small and small businesses do not have a similar means to adopt tangible ICT policies as their larger counterparts.

5. Availability of Data and Material

Information can be made available by contacting the corresponding author.

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Raheel Nawaz is an MS student in the Department of Management Sciences, COMSATS University Islamabad, Vehari Campus. His research is in HRM, ICT adoption, and Strategic Management.



Dr. Khuda Bakhsh is an Associate Professor (Economics) at the Department of Management Sciences, COMSATS University Islamabad, Vehari Campus. He holds a Ph.D. in Environmental and Resource Economics from the University of Agriculture, Faisalabad, Pakistan. His areas of interest are Environmental Economics, Managerial Economics, Sustainable Agriculture, Resource Economics, Environmental Science, Crop Management, Organic Farming, Marketing, Food Security, Econometrics, and ICTs Adoption.



Dr. Sami Ullah is a lecturer at the Department of Management Sciences, COMSATS University Islamabad, Vehari Campus. He holds a Ph.D. in management studies from Gomal University, D.I. Khan, KPK, Pakistan. His research is focused on Organizational Innovation, Technology management, ICTs Adoption, and SMEs Management.



Dr. Sana-ul-Rehman is an Assistant Professor at the Department of Business Administration, NFC Institute of Engineering and Technology, Multan Pakistan. He holds a Ph.D. in International Business from the Asian Institute of Technology Thailand. His areas of interest are Strategy Marketing and Corporate Social Responsibility.



Muhammad Azeem is an MS scholar at COMSATS University Islamabad, Vehari Campus. His research is focused on Strategic Management, Innovation, HRM, Marketing, Consumer Behavior, and Tourism.



Aamir Hayat is an MS scholar at COMSATS University Islamabad, Vehari Campus. His research interests are in Entrepreneurship, Innovation, HRM, Strategic Management, Organizational Behavior, and Business Ethics.



BIOSAFETY OF AUTOCHTON STRAINS OF MICROORGANISMS-PROBION AND THEIR JOINT COMPOSITION

Andrei Koshchayev ^{1*}, Albina Luneva ², Yury Lysenko ¹,
Alexander Lysenko ³, Azamat Shantyz ³

¹ Department of Biotechnology, Biochemistry and Biophysics, Kuban State Agrarian University named after I.T. Trubilin, RUSSIA

² Department of Parasitology, Veterinary Examination and Pet Hygiene, Kuban State Agrarian University named after I.T. Trubilin, RUSSIA

³ Department of Therapy and Pharmacology, Kuban State Agrarian University named after I.T. Trubilin, RUSSIA.

*Corresponding Author (Email: Koshchayev @ mail.ru).

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Abstract

The research work presents the results of studying the virulence, toxigenicity, and various types of toxicity of probiont strains isolated and identified by modern molecular genetic and microbiological methods from wild birds' gastrointestinal tract. In this work, laboratory animals were used for research, particularly nonlinear mice, rats, and albino rabbits. As a result of a complex of preclinical studies, it was revealed that experimental autochthonous strains of lactobacilli do not show signs of virulence, toxicity, toxicity, and a positive reaction to the production of hemolysin. In experiments on acute and chronic toxicity, regardless of the concentration of the studied strains introduced into the organism of laboratory animals, as well as their joint consortium in the composition of the probiotic, no death of the experimental animals was revealed, there were no signs of health disorders and body weight loss during the experiment. In general, the study results showed that the studied cultures of microorganisms and their consortium do not have a toxic effect on the organism of laboratory animals, both with a single and long-term use in the diet, which confirms their safety.

Disciplinary: Biotechnology, Bioscience.

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1. Introduction

Microflora, acting as antagonists to pathogenic microflora due to the significant content of important biologically active components in them and their ability to rapidly grow and accumulate large biomass.

The use of bacteria as raw materials to develop new-generation biological products capable of exhibiting probiotic and immunostimulating properties is profitable and promising. Therefore, in recent decades, a trend has changed the composition of microorganisms in the gastrointestinal tract, which has led to the creation of a new class of bacterial drugs - probiotics [1, 7].

The most crucial task in probiotics design is selecting bacterial strains that can effectively colonize the gastrointestinal tract and remain active for a long time. To do this, they are selected from existing collections, and they are screened among wild natural microorganisms that inhabit the tract of animals and humans [1, 5, 6, 8].

The study of scientific and patent material showed that today there are no effective designs of probiotic supplements prepared using the autochthonous (own) microflora of the gastrointestinal tract for use in industrial poultry farming.

This research aims to study the biosafety of new strains isolated from the gastrointestinal tract of wild birds.

2. METHOD

Research work was carried out at the Department of Biotechnology, Biochemistry, and Biophysics, as well as in the laboratory of preclinical and clinical studies of veterinary medicinal products and feed additives at the FSBEI HE Kuban State Agrarian University.

Determination of virulence, toxicity, toxicity, and harmlessness (hemolysin test), as well as the study of "acute" and "chronic" toxicity of probiont strains and their combined composition, was carried out on nonlinear mice (18-20 g) and rats (180-200 g) of both sexes according to methodological recommendations [2, 3]. Before setting up the experiment, laboratory animals were quarantined (acclimatization period), the duration of which was at least 3-4 days. During the quarantine, the experimental animals were examined daily (general condition and behavior). Light mode: 12 h light, 12 h darkness. The air temperature was maintained within the range of 19-25°C, relative humidity 65-70%. Experimental animals' maintenance corresponded to the current sanitary rules for the design, equipment, and maintenance of experimental biological clinics (vivariums) [4]. The formation of groups of experimental and control animals was carried out by the method of pairs-analogs.

Determination of the virulence of the tested strains. The 2nd passage culture, grown on a solid nutrient medium, was washed off with a 0.9% sodium chloride solution. In the resulting suspension, the concentration of microbial cells was determined using an optical turbidity standard. A series of tenfold dilutions were made from the resulting suspension. The resulting suspension of various concentrations (doses) of microbes was administered orally. The experiment used at least 10 animals per group. The administered dose was contained in a volume of 1.0 ml. The

test suspension of probiont strains was administered to mice fractionally during the day. The observation period was 14 days. The animals were observed daily, noting the number of live and dead animals in the experiment protocol. At the end of the observation period, the LD₅₀ was calculated.

Determination of the toxigenicity of the tested strains. The same principle studied the toxicity of microbes as virulence. For toxigenicity determining, the test strain culture was sown on a liquid nutrient medium, kept in a thermostat at an optimum temperature for growth for ten days to accumulate the toxin in it if the strain produces it. Then it was filtered through a bacterial filter. The resulting clear filtrate was introduced undiluted. Each dose of the filtrate was tested simultaneously on 10 laboratory animals when administered intraperitoneally.

Determination of the toxicity of the tested strains. The toxicity of the tested strains was checked by intraperitoneal administration of a suspension of the test strain (at the maximum concentration of microbial cells) killed by heating at a temperature of 100°C for 30 min. The heated culture, native, was injected into 10 animals in a volume of 1.0 ml and determined the LD₅₀ or maximum tolerated dose. The animals were observed for 14 days.

Hemolysin test. 5% defibrinated ram blood was added to the MRS nutrient medium melted and cooled to 48-50°C. After pouring the medium into Petri dishes in a thin layer (1.5-2 mm), an 18-hour culture was inoculated on the solidified and dried surface by streaking to obtain isolated colonies. The dishes were incubated at a temperature of (37±1)±C for 24-48 h, after which the results were recorded.

Determination of the dermonecrotic properties of the tested strains. For this purpose, white-skinned rabbits of the chinchilla breed weighing 1.5-2.5 kg were used in 3 heads per group. Different microbial suspension concentrations in a volume of 0.1-0.2 ml were injected intradermally into the back. The skin at the suspension injection site was preliminarily freed from wool and treated with 70% ethanol. At the injection site, the skin was stretched with the left hand's fingers, and the needle was inserted with the right hand at an acute angle. The daily result was recorded for 3-4 days. The appearance of swelling, redness, and the presence of necrosis were noted.

Study of "acute" toxicity. In the study of "acute" toxicity, three different doses of the tested cultures of strains and a probiotic were administered once orally to determine the LD₅₀ or the maximum tolerated dose. The control group of animals was injected with a 0.9% sodium chloride solution in the same way. Intact animals were formed from the same group (control group 2). The total duration of observations of the animals was 7 days. The animals' death, body weight, and the presence or absence of possible clinical symptoms of intoxication, including impaired coordination of movement, presence of seizures, their nature, and scalp condition, the color of mucous membranes, and tail position were recorded daily.

Determination of "chronic" toxicity. The strains and their composition as part of the probiotic were administered daily, the duration of administration was 30 days. "Chronic toxicity" was

determined in nonlinear mice and rats. Observation of the animals was carried out during the introduction of strains and biological products and the next 7 days. The death of animals, body weight, as well as presence or absence of possible clinical intoxication symptoms, including impaired coordination of movement, presence of seizures, their nature, and scalp condition, the color of mucous membranes, tail position, were recorded daily. At the end of the experiment, blood was taken to analyze its morpho-biochemical parameters, and pathomorphological studies were carried out, taking material from the internal organs of surviving animals. Before the collection of internal organs, they were visually examined, and macroscopic changes were recorded.

The results obtained in the course of research experiments were processed by the method of variation statistics. The difference was regarded as significant at $P < 0.05$.

3. RESULT AND DISCUSSION

3.1 Virulence of the Tested Strains

Virulence is a biological property of microorganisms that characterizes the degree of their pathogenicity. In contrast to pathogenicity, virulence is not specific, but an individual feature of a microbe, which can be intensified or weakened up to complete disappearance under the influence of various factors. The virulence results of the studied cultures are in Tables 1 and 2.

Table 1: Results of studying the virulence of *Lactobacillus sp. 1* in mice and rats ($n = 10$)

Group	Kind of animal	The volume of injected fluid, method of medication	Strain dose, CFU/ml	The test result, heads		
				got sick	dead	survived
1st experimental	mice	1.0 ml <i>Lactobacillus</i> sp.1, orally	5.4×10^{10}	0	0	10
	rats					10
2nd experimental	mice	1.0 ml <i>Lactobacillus</i> sp.1, orally	5.4×10^9	0	0	10
	rats					10
3rd experienced	mice	1.0 ml <i>Lactobacillus</i> sp.1, orally	5.4×10^8	0	0	10
	rats					10

Table 2: Results of studying the virulence of *Lactobacillus sp. 2* in mice and rats ($n = 10$)

Group	Kind of animal	The volume of injected fluid, method of medication	Strain dose, CFU/ml	The test result, heads		
				got sick	dead	survived
1st experimental	mice	1.0 ml <i>Lactobacillus</i> sp.2, orally	3.5×10^{10}	0	0	10
	rats					10
2nd experimental	mice	1.0 ml <i>Lactobacillus</i> sp.2, orally	3.5×10^9	0	0	10
	rats					10
3rd experienced	mice	1.0 ml <i>Lactobacillus</i> sp.2, orally	3.5×10^8	0	0	10
	rats					10

The results of the virulence of probiont strains used showed that, regardless of the concentration of laboratory animal cultures introduced into the body, no death of experimental animals was detected, there were no signs of health disorders and body weight loss by the end of the observation period (on the 14th day). It was not possible to determine LD₅₀, and the initial concentration of the tested strains was taken as the maximum tolerated dose, which for *Lactobacillus* sp. 1 was 5.4×10^{10} CFU/ml, and for *Lactobacillus* sp.2 3.5×10^{10} CFU/ml, which will then be used as starting points in the assessment of "acute toxicity". Thus, the studied cultures of lactobacilli do not show virulence.

3.2 Toxicity of the Tested Strains

The results of studying the toxigenicity of the probiont strains under study are in Table 3. The absence of death of animals, signs of health disorders, and loss of body weight in mice and rats by the end of the experiment was established, which indicates the absence of a toxic agent in the filtrate of the tested cultures. Thus, *Lactobacillus* sp. 1 and sp. 2 are not toxigenic.

Table 3: Results of studying the toxigenicity of the studied cultures in laboratory animals (n = 10)

Group	Kind of animal	The volume of injected fluid, method of medication	The test result, heads		
			got sick	dead	survived
1st experimental	mice	1.0 ml filtrate <i>Lactobacillus</i> sp.1, intraperitoneally	0	0	10
	rats				10
2nd experimental	mice	1.0 ml filtrate <i>Lactobacillus</i> sp.2, intraperitoneally	0	0	10
	rats				10

3.3 Toxicity of the Tested Strains

The results of the study of the toxicity of the studied lactobacilli show in Table 4. As a result of studying the toxicity of the strains in the experimental groups, all experimental animals survived. No signs of health disorders and loss of body weight in mice and rats were recorded by the end of the experiment. Thus, the probiont strains under study are not toxic.

Table 4: Results of studying the toxicity of the studied cultures in laboratory animals (n = 10)

Group	Kind of animal	The volume of injected fluid, method of medication	The test result, heads		
			got sick	dead	survived
1st experimental	mice	1.0 ml dead weight <i>Lactobacillus</i> sp.1, intraperitoneally	0	0	10
	rats				10
2nd experimental	mice	1.0 ml dead weight <i>Lactobacillus</i> sp.2, intraperitoneally	0	0	10
	rats				10

3.4 Hemolysin Test

An additional indicator of the safety of the tested strains is the hemolysin production test. Some bacteria produce hemolysins (substances that destroy red blood cells), which are pathogenic factors. In this regard, the production of hemolysin in many cases is a marker of virulence. On blood agar, the grown colonies of such microorganisms surround the zones of enlightenment, see the results in Figure 1.



Figure 1: Hemolysin production by lactobacilli (no clearing zones)

The hemolytic properties of microbes were studied on an MRS medium with defibrinated ram blood. As a result of the experiment, during the cultivation of the studied strains on 5% blood agar, the hemolysis (clearing) zone around the colonies was not revealed, the result of hemolytic properties was negative. Thus, the cultures of lactic acid bacteria used are safe.

3.5 Dermonecrotic Properties of Strains

Three groups of rabbits were formed. The control group, which were injected subcutaneously with saline in a volume of 0.1 ml, and two experimental ones, which were injected with the corresponding microbial suspension in a volume of 0.1 ml. The result was taken into account daily for 4 days. The injection place of suspension is shown in Figure 2.

As a result of the experiment, there was no swelling, redness, areas of necrosis, and other pathologies at the injection site of solutions both in the control and in the experimental groups. Thus, the probiont strains under study do not have dermonecrotic activity. The volume of injected fluid, the method of medication.



Figure 2: Injection area of research objects

3.5.1 Acute Toxicity

The study of the parameters of "acute" toxicity of the studied cultures and their consortium in the composition of the probiotic was carried out on nonlinear white mice and rats. The maximum tolerated concentrations studied in probiont strains' virulence study, namely, for Lactobacillus sp.1 5.4×10^{10} CFU/ml and Lactobacillus sp.2 3.5×10^{10} CFU/ml. Three doses were studied for their joint composition. As the maximum allowable dose, the concentration of microorganism cells contained in 1.0 ml of the probiotic was used, and additionally, doses contained in volumes of 0.2 and 0.5 ml were used. The acute toxicity results are in Table 5.

The results of a 7-day study of "acute" toxicity showed that in the 1st control group (intact), in the 2nd control group, and all experimental groups (1st to 5th) with a daily observation of laboratory animals, it was revealed that they remained mobile, active, ate food mixtures well, deaths of mice and rats were not registered, clinical symptoms of intoxication did not appear, the

condition of the scalp, as well as the color of the visible mucous membranes, were normal. Thus, the studied probiotic strains and their combined composition (probiotic) do not cause severe toxicosis in laboratory animals.

Table 5: Results of the study of acute toxicity of the studied cultures and probiotic in laboratory animals (n = 10)

Group	Kind of animal	The volume of injected fluid, method of medication	Strain dose, CFU/ml	The test result, heads		
				got sick	dead	survived
1st control (intact)	mice	—	—	0	0	10
	rats					10
2nd control	mice	1.0 ml physical solution, orally	—	0	0	10
	rats					10
1st experimental	mice	1.0 ml Lactobacillus sp. 1, orally	5.4×10^{10}	0	0	10
	rats					10
2nd experimental	mice	1.0 ml Lactobacillus sp. 2, orally	3.5×10^{10}	0	0	10
	rats					10
3rd experienced	mice	0.2 ml probiotic, orally	1.8×10^9	0	0	10
	rats					10
4th experimental	mice	0.5 ml probiotic, orally	4.5×10^9	0	0	10
	rats					10
5th experienced	mice	1.0 ml probiotic, orally	8.9×10^9	0	0	10
	rats					10

3.5.2 Chronic Toxicity

The chronic toxicological experiments are to characterize the degree of the damaging effect of the studied strains and probiotic supplements during their long-term administration (30 days), to identify the most sensitive organs and systems of the body, as well as to study the degree of reversibility of the damage caused by them. As the studied doses for the test cultures and their joint composition in the probiotic composition, the maximum tolerated concentrations studied in the study of "acute" toxicity were used. Chronic toxicity results are in Table 6.

Table 6: Results of studying the "chronic" toxicity of the studied cultures and probiotic in laboratory animals (n = 10)

Group	Kind of animal	The volume of injected fluid, method of medication	Strain dose, CFU/ml	The test result, heads		
				got sick	dead	survived
1st control (intact)	mice	—	—	0	0	10
	rats					10
2nd control	mice	1.0 ml physical solution. orally	—	0	0	10
	rats					10
1st experimental	mice	1.0 ml Lactobacillus sp. 1. orally	5.4×10^{10}	0	0	10
	rats					10
2nd experimental	mice	1.0 ml Lactobacillus sp. 2. orally	3.5×10^{10}	0	0	10
	rats					10
3rd experienced	mice	1.0 ml probiotic. orally	8.9×10^9	0	0	10
	rats					10

The results of daily visual observation of the behavior of laboratory mice and rats for 30 days and the next 7 days showed that the experimental animals in all groups remained active and mobile, satisfactorily ate food and consumed water, clinical signs of intoxication and mortality of biological objects from the action of the studied strains and probiotic not found. The coat was smooth with a characteristic luster. The skin and the color of the visible mucous membranes were pale pinks, typical of healthy animals.

When carrying out "chronic" toxicity, we studied the effect of the test objects on the weight gain of laboratory mice and rats during the period of experiments. The weights of laboratory animals were taken into account at the beginning experiment and the 30th day after its completion. The results of the live weight of laboratory animals are in Table 7.

Table 7: Results of the influence of the studied cultures and probiotic on the live weight of laboratory animals

Group	Body weight, g		Experience gain, g
	at the beginning of the experiment	at the end of the experiment	
Mice			
1st control (intact)	18.5 ± 0.3	22.4 ± 0.3	3.9
2nd control	18.3 ± 0.4	22.5 ± 0.4	4.2
1st experimental	18.5 ± 0.3	24.2 ± 0.4	5.7
2nd experimental	18.7 ± 0.4	24.5 ± 0.4	5.8
3rd experienced	18.6 ± 0.3	26.8 ± 0.3*	8.2
Rats			
1st control (intact)	193.5 ± 2.1	210.8 ± 1.8	17.3
2nd control	192.7 ± 2.3	211.3 ± 1.8	18.6
1st experimental	193.3 ± 1.9	217.7 ± 2.1	24.4
2nd experimental	191.9 ± 2.0	218.3 ± 2.0	26.4
3rd experienced	192.2 ± 2.1	222.6 ± 1.8*	30.4

* The difference with the 2nd control group is significant ($P < 0.05$)

When studying the influence of the studied cultures of lactic acid bacteria and their compositional form of probiotic on the live weight of laboratory animals, it was found that in the 1st and 2nd experimental groups of mice, compared with the same in the 2nd control group, there was a positive dynamics in live weight, which was higher by 7.6 and 8.9%, respectively, but the difference was not significant. A similar situation was recorded in the groups of laboratory rats. In the 1st and 2nd experimental groups, there was an increase in animals' live weight compared to the 2nd control by 3.0 and 3.3%. Statistically significant differences in live weight were found in the 3rd experimental group of mice and rats concerning the 2nd control group. So in the 3rd experimental group of mice at the end of the experiment, the live weight exceeded the 2nd control group of mice by 19.1% ($P < 0.05$), and in rats by 5.3% ($P < 0.05$) with significant differences.

The influence of the probiont strains and probiotic additives on the morphological and biochemical parameters of the blood of laboratory animals was studied. The research results are in Tables 8 and 9.

Table 8: Data on morphological and biochemical parameters of the blood of mice ($n = 6$)

Index	Group				
	1st control (intact)	2nd control	1st experimental	2nd experimental	3rd experienced
Leukocytes, $10^9 / \text{L}$	7.5±0.2	7.4±0.2	7.5±0.3	7.6±0.3	7.7±0.2
Erythrocytes, $10^{12} / \text{L}$	8.3±0.2	8.4±0.2	8.5±0.3	8.5±0.2	8.7±0.3
Platelets, $10^9 / \text{L}$	241.2±3.1	240.4±3.3	242.8±3.1	242.2±3.3	243.6±3.4
Hemoglobin, g / L	122.3±2.3	123.4±2.5	125.4±2.5	125.8±2.3	126.6±2.4
Total protein, g / L	52.5±1.2	52.8±1.1	54.3±1.0	53.8±1.1	56.3±1.3
Glucose, mM / L	4.5±0.2	4.6±0.1	4.6±0.1	4.7±0.2	4.6±0.1
Urea, mM / L	6.2±0.2	6.4±0.1	6.4±0.2	6.3±0.2	6.4±0.2
Cholesterol, mM / L	2.5±0.1	2.5±0.1	2.4±0.1	2.5±0.1	2.3±0.1
Calcium, mM / L	2.3±0.1	2.4±0.1	2.3±0.1	2.4±0.1	2.5±0.1
Phosphorus, mM / L	1.3±0.02	1.3±0.03	1.4±0.01	1.4±0.02	1.5±0.02
AsAT, U / L	115.6±3.5	113.8±3.6	116.5±3.5	115.7±3.4	116.4±3.6
ALAT, U / L	55.4±2.7	56.7±2.9	54.7±2.6	55.84±2.9	56.4±2.7

Studying the morphological and biochemical data of the blood of laboratory mice showed positive dynamics in the experimental groups in terms of the studied parameters. However, in the groups' context, no significant difference was found. Moreover, all indicators were within the physiological norm for a given type of laboratory animal. The positive dynamics in erythrocytes content should be noted, which level in the 1st, 2nd, and 3rd experimental groups was higher than in the 2nd control group by 1.2 and 3.6%, platelets 1.0; 0.7 and 1.3% and hemoglobin by 1.6; 1.9 and 2.6%. The positive dynamics in the studied indicators indicate a better saturation of organs and tissues of mice with oxygen since hemoglobin is responsible for binding with oxygen, and red blood cells (erythrocytes) carry it with the bloodstream. As a result, an acceleration of redox reactions in the body is observed. The amount of total protein in the mice's blood in the experimental groups also slightly exceeded the control groups. In contrast, the 1st experimental group's total protein was higher than in the 2nd control by 2.8%, in the 2nd experimental group by 1.9%. The highest value was observed in the 3rd experimental group, which surpassed the similar control group by 6.6%. No particular difference was found for the rest of the biochemical parameters, and they were at the normal level.

Table 9: Data on morphological and biochemical parameters of the blood of rats ($n = 6$)

Index	Group				
	1st control (intact)	2nd control	1st experimental	2nd experimental	3rd experienced
Leukocytes, $10^9/1$	11.3 \pm 0.3	11.5 \pm 0.4	11.3 \pm 0.4	11.4 \pm 0.3	11.5 \pm 0.4
Hemoglobin, g/1	103.6 \pm 3.7	104.7 \pm 3.6	106.1 \pm 3.7	106.4 \pm 3.8	107.4 \pm 3.6
Platelets, $10^9/1$	152.5 \pm 3.6	153.3 \pm 3.5	154.3 \pm 3.4	154.8 \pm 3.2	155.8 \pm 3.4
Erythrocytes, $10^{12}/1$	5.3 \pm 0.2	5.3 \pm 0.1	5.5 \pm 0.2	5.4 \pm 0.2	5.5 \pm 0.1
Total protein, g/1	66.1 \pm 1.5	65.1 \pm 1.3	68.6 \pm 1.6	68.5 \pm 1.8	69.3 \pm 1.5
Glucose, mM/1	4.1 \pm 0.2	4.2 \pm 0.1	4.2 \pm 0.2	4.2 \pm 0.1	4.2 \pm 0.2
Urea, mM/1	5.6 \pm 0.1	5.6 \pm 0.2	5.5 \pm 0.2	5.6 \pm 0.1	5.5 \pm 0.2
Cholesterol, mM/L	1.8 \pm 0.04	1.8 \pm 0.03	1.7 \pm 0.03	1.8 \pm 0.05	1.8 \pm 0.04
Calcium, mM/1	2.4 \pm 0.1	2.5 \pm 0.1	2.6 \pm 0.1	2.6 \pm 0.1	2.6 \pm 0.1
Phosphorus, mM/1	13.1 \pm 0.3	13.2 \pm 0.3	13.3 \pm 0.4	13.4 \pm 0.2	13.5 \pm 0.3
AsAT, U/1	53.6 \pm 2.1	54.5 \pm 1.8	55.4 \pm 2.2	54.3 \pm 1.8	55.1 \pm 1.9
ALAT, U/1	65.3 \pm 2.4	65.6 \pm 2.3	65.4 \pm 1.9	66.3 \pm 2.3	66.7 \pm 2.1

The analysis of the blood of laboratory rats' morphological and biochemical parameters also revealed a positive trend in the studied parameters in the experimental groups, in the diet of which the studied cultures and the probiotic were used. Similarly to mice, erythrocytes, hemoglobin, platelets, total protein, calcium, and phosphorus levels were also slightly increased in the blood of rats of the experimental groups, within the physiological norm, which confirms the positive effect of the objects of research on the organism of laboratory animals.

During the postmortem examination of mice and rats of all the studied groups, changes in the location and structure of internal organs were not established; from the perspective of anatomy, the organs in the cavities were located correctly. Deviations and changes in the macroscopic structure of organs were not established, fluid in the cavities was not detected, the presence of fat was noted in the retroperitoneal tissue, and in the perirenal state, the lumen of the trachea and bronchi of mucus, catarrhal and purulent exudate was not found, the lung tissue was pink, without foci of necrosis.

The submandibular lymph nodes and salivary glands were rounded, uniform pinkish or yellowish, and moderately dense. The thyroid gland was tightly attached to the larynx, had a standard size and density, pinkish-reddish in color.

The stomach is not enlarged, the lumen is not filled with anything. The mucous membrane of the stomach is pale pink, shiny, folded. The mucous membranes of the small and large intestines are unchanged.

Liver - not enlarged, dark cherry color, with a smooth surface and moderately dense texture. The liver capsule is thin, transparent, smooth, shiny, without foci of necrosis and degenerative changes.

Heart - no pathological changes.

The lungs are pale pink, without pathologies.

The kidneys are not enlarged in volume. The tissue is elastic, the kidneys' capsule is easily separable, and the cortex and medulla layers are visible on the cut. Hemorrhages and macrostructural changes in the renal tissue were not identified.

The spleen is dark cherry, with a smooth surface, dense texture.

In general, the results of comprehensive studies indicate that there is no additional load on the organs and systems of the body with prolonged oral administration of a probiotic supplement.

4. CONCLUSION

The probiont strains used in this work, which have been isolated and identified from the gastrointestinal tract of wild birds by modern molecular genetic and microbiological methods, are safe. As a result of a complex of preclinical studies, it was revealed that these lactobacilli cultures do not show signs of virulence, toxicity, toxicity, and a positive reaction to the production of hemolysin. In experiments on acute and chronic toxicity, regardless of the concentration of the studied strains introduced into the organism of laboratory animals, as well as their joint consortium in the composition of the probiotic, no death of experimental animals was revealed, there were no signs of health disorders and loss of body weight during the experiment, animals remained mobile, active, ate feed mixtures well, no clinical symptoms of intoxication appeared, the condition of the scalp, as well as the color of the visible mucous membranes, remained normal. In general, the study results showed that the studied cultures of microorganisms and their probiotic form do not have a toxic effect on the organism of laboratory animals, both with a single and long-term use in the diet, which confirms their safety.

5. AVAILABILITY OF DATA AND MATERIAL

Data can be made available by contacting the corresponding author.

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Professor Dr. Andrei Koshchayev is at the Department of Biotechnology, Biochemistry and Biophysics, Kuban State Agrarian University named after I.T. Trubilin, RUSSIA. He holds a Doctor of Biological Sciences



Albina Luneva is an Associate Professor of the Department Parasitology, Veterinary Examination and Pet Hygiene, Kuban State Agrarian University named after I.T. Trubilin, RUSSIA. She is a Candidate of Biological Sciences.



Yury Lysenko is an Associate Professor of the Department of Biotechnology, Biochemistry and Biophysics, Kuban State Agrarian University named after I.T. Trubilin, RUSSIA. He is a Candidate of Biological Sciences



Professor Dr. Alexander Lysenko is at the Department of Therapy and Pharmacology, Kuban State Agrarian University named after I.T. Trubilin, RUSSIA. He holds a Doctor of Veterinary Sciences



Professor Dr. Azamat Shantyz is at the Department of Therapy and Pharmacology, Kuban State Agrarian University named after I.T. Trubilin, RUSSIA. He holds a Doctor of Veterinary Sciences.



Dynamic Measuring the Impacts of Financial Fragility on the Performance of Non-Financial Firms Listed at the Pakistan Stock Exchange

Muhammad Munir Ahmad¹, Salman Ali Qureshi²,
Muhammad Bilal^{3*}, Naveed⁴, Asif Mehmood Rana⁵

¹ Department of Commerce, Allama Iqbal Open University, Islamabad, PAKISTAN.

² Department of Business Administration, Allama Iqbal Open University, Islamabad, PAKISTAN.

³ Department of Business & Economics, FG Sir Syed College, Rawalpindi, PAKISTAN.

⁴ Department of Management Sciences, Qurtuba University of Science and Information Technology, Peshawar, PAKISTAN.

⁵ Department of Business Administration, Federal Urdu University of Arts, Science & Technology, Islamabad, PAKISTAN.

*Corresponding Author (Email: rao.muhammad.bilal@gmail.com).

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Abstract

Financial fragility (FFR) is of great importance due to its impacts on the dynamics of firms. This paper explores the presence of FFR and its impacts on the performance of manufacturing firms listed at the Pakistan Stock Exchange (PSX) for 2010-2019. The sample data set is split based on median values of fragility, age, and size of the firms, and then classified as fragile, non-fragile, large, small, old, and younger firms. Using the fixed effect, random effect, and pooled OLS techniques to examine relationships among the variables, the Return on Assets, and Tobin's Q ratios are used as performance measures that show the negative relationship with FFR. Firms with good equity ratios are good performers due to their financial strength. Younger firms are better performers than older firms are, but FFR plays an adverse role for all firms. Larger firms' performances are better, compared to smaller firms. The presence of fragility does not hamper the performance of large size firms while small-size firms are more affected. The study results suggest utilizing retained earnings and reducing dependence on debt financing to improve the financial performance of fragile firms.

Disciplinary: Financial and Management Sciences.

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1. Introduction

The prosperity of the firms originates due to versatile interactions taking place between different alternatives and features of the organization. It is also argued that the performance of the firm is influenced by its strategies to capture market share, acquisition of financial resources, Research, and Development, investment decisions, and management of financial resources. More important among these is the financial management policy formulating diverse decisions regarding investing, financing, operating, and disbursement of dividends (Bottazi et al., 2007). However, Beck (2012) is of the view that factors that assist financial progression may also lead to financial shocks leading towards financial fragility (FFR). Another viewpoint, Carletti (2008) explains important determinants of FFR that includes asymmetric information, and agency issue among the savers (depositors), and managers (entrepreneurs) of the firms resulting in uncertainty of the financial position of banks. Due to which depositors (savers) pressurize banks to take excessive risk. Such circumstances result in financial fragility.

Modigliani and Miller (1958) ascertain that financing decisions are irrelevant due to perfect capital markets. However, researchers at the micro-level attempted to investigate the relationship between real, and financial decisions of corporations. Contrary to Modigliani, and Miller (1958) Hubbard (1998) proved that a relationship persists among investment and financial position of corporations. Additionally, Hericourt & Poncet (2009) shed light on the fact that FFR occurs due to internal funds, and imperfection in the capital market could be the major cause of difference amongst the costs of both internal as well as external financing.

Pakistan is among the developing countries, and improvements in the manufacturing sector are inevitable for the progress of the economy. Presently, most of the firms in the manufacturing sector are not performing up to the mark, and their performance is declining (Ministry of Finance of Pakistan, 2018). Some important areas like financial fragility and credit constraints could be the cause of weak financial performance. Therefore, the present study aims to address some important questions; does financial fragility deteriorate the firm performance? How financial fragility affect different size firms, and how the performance of younger/older firms is affected by financial fragility? Additionally, results are of great concern for the credit market policy decision-makers for formulating specific guidelines for a variety of firms operating under non-financial sectors in the economy.

2. Literature Review, and Hypothesis Development

Financial markets are assumed to be perfect in theory; however, in reality, imperfections prevail in the credit markets that create volatility (Coricelli & Mastern, 2004). Literature highlights the distortion affects FFR on the dynamics of firms which leads to sluggish growth, and investment of corporations (Clementi & Hopenhyan, 2006). Hence due to fragility firms are unable to expand their business operations at national, and international levels. Minetti and Zhu (2011) explained that financial fragility hinders firms to enter international markets.

In developing economies, the survival and growth of the firms are critical because financial markets are not easily accessible. Financial fragility act as a barrier for better investment, and performance of the firm (Stein, 2003). It has a negative impact on firm performance and behaves as a decisive factor in devising a firm's capital structure. Fragile firms incur the direct costs for financial advisers, lawyers, and accountants. Vitali et al. (2011) stated that with the increase in the debt of the firm, the default risk increase, and banks lend the money to fragile firms at higher interest. This higher financial cost decreases the firm profitability and overall performance. They further argued that the probability of the financial fragility of that firm is more in the future than the probability of being healthier.

Thus, the hypothesis is developed as

***H₁:** The presence of financial fragility is harmful to accounting as well as the market performance of the firms.*

Ages of the firms have been studied and discussed by many researchers in finance literature as a control variable. Some of the authors used age to measure financial constraints (Kaplan & Zingales, 1997), and others used it for diversification (Villalonga, 2004). Baker et al. (2003) utilized age to measure the financing constraints and found that the younger firms are more constrained as compared to the older firms. Many of the other researchers empirically tested the impact of age on the firm's performance. Older firms performed better than the younger firms due to more experience, reported by some of the researchers (Agarwal et al., 2002). Some other researchers reported a negative relation between firm performance and the age of the firm. Loderer and Waelchli (2009) used the variable age as an independent variable and reported that older firms perform worse due to organizational rigidities, seniority rules, and inertia problem.

Thus, the hypothesis is developed to test the phenomenon regarding the impact of firm size on the firm's performance in the presence of FFR.

***H₂:** The performance of younger firms is better than the performance of older firms, and is negatively affected by the presence of financial fragility.*

Mixed results have been found in the literature regarding the impacts of size on performance. Some reported positive impacts of size on the performances of firms and proved that the larger firms perform better as compared to smaller firms (Wu, 2006). The results of other authors agree with Fama, and French (2005) who reported the negative impact of size on the firm.

Thus, the third hypothesis is developed as

***H₃:** Performance of the large size firms is better than the performance of the small size firms, in the presence of financial fragility.*

3. METHOD

The study aims to investigate the impact of financial fragility on the firm's performance. Data for analysis is collected from the balance sheet statements analysis published by the State Bank of Pakistan. The sample contains 250 PSX listed firms across the different non-financial sectors for the period 2010 to 2019. For the data analysis purpose, different techniques are used in

this study including descriptive statistics, correlation analysis, and regression analysis i.e. Pooled Ordinary least square (POLS), Fixed Effect Method (FEM), and Random Effect Method (REM). Table 1 describes the detail of the variables used in this study.

Table 1: Variables Measurements.

Name of Variable	Measurement	Literature Support
Firm Performance (PR)	Return on Assets (ROA) = $\frac{\text{Net Profit}}{\text{Total Assets}}$ Tobin's Q (TQ) = $\frac{(\text{MVE}+\text{BVD})}{\text{BVA}}$	Kalkan et al. (2011) Loderer & Waelchli (2009) Chathoth & Olsen (2007) Mao & Gu (2008)
Financial Fragility (FFR)	FFR = $\frac{\text{Equity}}{\text{Assets}}$	Agliari et al. (2006) Vitali et al. (2016) Chan et al. (2012) Fazzari et al. (1988)
Age (AG)	Ln of date of listing	Agarwal et al. (2002) Loderer & Waelchli (2009) Shumway (2001)
Size (SZ)	Ln of the BVA	Mao & Gu (2008) Wu (2006) Kalkan et al. (2011)
Growth (GR)	GR = $\frac{\text{Sales}_t}{\text{Sales}_{t-1}} - 1$	Majumdar (1997) Mao & Gu (2008)
Activity (AC)	AC = $\frac{\text{Sales}}{\text{Assets}}$	Moyer et al. (2001) Kiymaz (2006)
Cash Flow (CF)	Net Profit after taxes plus depreciation	Fazzari et al. (1988) Chen et al. (2007) Hong et al. (2012)

Note: MVE = market value of equity, BVD = book value of debt, BVA = book value of the total assets.

3.1 Empirical Specifications

The magnitude of the relationship between the dependent variables (DV) and explanatory variables is tested by applying the inferential statistical analysis. The basic regression model is developed as

$$PR_{it} = \alpha_i + \beta_1 FFR_{it} + \beta_2 AG_{it} + \beta_3 SZ_{it} + \beta_4 GR_{it} + \beta_5 AC_{it} + \beta_6 CF_{it} + \varepsilon_{it} \quad (1).$$

The subscript i is used for each cross-section unit or firm in the sample data set. Subscript t denotes the period for the variables. α_i is the regression constant, β_1, β_2 , and β_3 are the regression coefficients of fragility (FFR), age (AG), and size (SZ) of the firm, respectively. Similarly, β_4, β_5 , and β_6 are the regression coefficients of growth (GR), activity (AC), and cash flow (CF). ε_{it} indicates the unexplained portion of the regression model.

To meet the objectives of the study, the sample data set is split based on the first three independent variables; fragility, age, and size of the firms using the median value. If the value of the firm is less than the median value that is classified as a fragile firm, otherwise non-fragile firms (Arslan-Ayaydin et al., 2006). If the Firm's age is greater than the median value of the age, then the firm is grouped as the older firm, otherwise as to the younger firm (George et al., 2011). Similarly, firms having larger value than the median, are classified as larger firms otherwise are grouped in small-sized firms. Each group consists of 125 cross-section units.

4. RESULT AND DISCUSSION

Table 2 describes the study results including the descriptive statistics, The mean and median values of the ROA are 4.2%, and 2.7%, which depicts the low performance of the firms. The minimum value is in the negative, which is due to the loss of the firm, the highest value is 87.52%. The average TQ shows that the market value of the firm is more than the book value of the firm, and there are many such firms, whose market value is less than the book value of the firm.

Table 2: Descriptive Statistics.

Variable	Mean	Median	SD	Minimum	Maximum	Jarque-Bera Test	
						Value	Sig.
ROA	0.042	0.027	0.151	-1.961	0.875	3.502	0.174
TQ	1.364	1.025	1.709	0.059	43.622	1.733	0.42
FFR	0.287	0.352	0.530	-8.118	1	1.945	0.378
GR	0.152	0.065	0.352	-0.854	3.490	1.661	0.436
SZ	5754.5	1035.7	17977.4	1.1	208070		
SZ(LN)	7.096	6.943	1.687	0.095	12.246	6.294	0.043
AG	23.312	18.911	12.489	2	61.792	0.391	0.822
AC	1.184	0.975	1.341	0.002	24.849	1.262	0.532
CF	554.245	56.473	3263.34	-31972.6	57600.3	0.851	0.654

The fragility of firms is determined based on median value, that the firms less than the median value are considered as the fragile firms. The value of mean 0.29 is less than the value of median 0.35, which means that the fragile firms are more in numbers than the non-fragile firms in the sample data. Data of fragility deviate from its mean by 0.529. The minimum value of the variable is very critical that is -8.12. It means that there are such firms in the sample data set which have been suffering losses continuously. These losses bring the equity of the firm negative gradually and lead to the insolvency of the firms. The maximum value of the firm is 1 which indicates that the assets of the firms are approximately 100% backed by the shareholder's equity. The growth of the majority of firms is not only low but also negative growth. Minimum and maximum values of size show that in the sample data set there are varieties of firms.

Table 3: Results of REM of Fragile & Non-Fragile Firms.

Variables	DV: ROA Model 1	DV: TQ Model 2	DV: ROA Model 3	DV: TQ Model 4
	Fragile Firms		Non-Fragile Firms	
Constant (C)	0.994*** (0.032)	0.971*** (0.032)	-0.013 (0.015)	-0.165** (0.080)
FFR	-1.005*** (0.030)	-1.009*** (0.030)		
NFR			0.100*** (0.023)	0.237* (0.131)
GR	0.021* (0.011)	0.022** (0.011)	0.0332*** (0.010)	0.046 (0.054)
AC	0.288*** (0.024)	0.310*** (0.024)	0.023*** (0.002)	0.044*** (0.013)
CF	0.003*** (<0.001)	0.003*** (0.001)	0.001*** (<0.001)	<0.001** (<0.001)
F- Statistic	1.213***	1.217***	1.2724**	4.554***
H-Test	6.75	6.548	2.098	1.290

***, **, * show the significance of results at 1%, 5%, and 10% level of significance respectively.

NFR = Financial Fragility for Non-Fragile Firms.

The values of F-Test and H-Test reported in Table 3 confirm the validity of REM for analysis. The beta coefficient of fragility describes that there is the negative impact of a firm's fragility on its

performance. Rests of the variables are all significant except the growth variable, whose significance level is low. The coefficient of Cash flow seems very low apparently. The reason for the low beta coefficient is that it is in million rupees. In Model 2, the beta coefficient of fragility is also narrated that there is a negative impact of firm's fragility on their market performance as well. The results imply that the firm should reduce the leverage, and retained earnings should be utilized for further financing as described in the pecking order theory (Myers, 1984). If there are no retained earnings to be utilized for financing even then the firm should be careful to use the debt as external financing. In Model 3 beta coefficient of healthy firms is 0.1, which captures the change in performance. The beta coefficient of the growth variable is highly significant and has more explanatory power than the beta coefficient of fragile firms. The coefficient of Cash flow confirms the less dependence of performance on internal cash flows in the case of financially sound firms. In model 4, the variable of NFR is negative, and the reason for the negative intercept is that if there is no impact of good equity ratio on performance it leads to negative performance. This justification may be confirmed from the independent variable NFR, as it has a significant positive impact on the performance. Therefore, the hypothesis **H1** is accepted as indicated by the results in Table 3.

Table 4: Results of FEM of Older & Younger Firms

Variables	DV: ROA Model 5	DV: TQ Model 6	DV: ROA Model 7	DV: TQ Model 8
	<i>Older Firms</i>		<i>Younger Firms</i>	
AG	-0.004* (0.002)	-0.004** (0.002)	0.013** (0.006)	0.013*** (0.002)
GR	0.028*** (0.009)	0.0103 (0.009)	0.002** (<0.001)	0.003*** (0.002)
AC	0.047*** (0.016)	0.0003*** (0.000)	0.029** (0.009)	0.050*** (0.003)
CF	<0.001*** (0.000)	0.00001*** (0.000)	<0.001*** (0.000)	0.000 *** (0.000)
AG*FFR	-0.001*** (<0.001)	-0.001*** (<0.001)	-0.003*** (<0.001)	-0.003*** (<0.001)
Adj. R²	0.462	0.438	0.275	0.432
F- Statistic	4.978***	4.772***	1.435***	1.680***
H-Test	29.832***	36.132	24.290	20.692

***, **, * the significance of results at 1%, 5%, and 10% level of significance, respectively.

In Table 4, age shows the negative impact on the performance of firms describing that the performance of older firms is not better as compared to the younger firms due to organizational rigidities, seniority rules, and inertia problems as described by Loderer, and Waelchli (2009). The interaction dummy variable of age and fragility shows that the incorporation of fragility in old age firms increases the negative impact on performance. The model 6 results show the larger negative impact on the market performance of the firm as compared to the impact on accounting performance. The interaction dummy variable of age and fragility in this case also describes the negative impact on the performance of the firm and is highly significant than the age variable. It shows that the incorporation of fragility in old age firms increases the negative impact on performance. The interaction dummy variable of age and fragility, in this case, describes the negative impact on the performance of the firm. It shows that the incorporation of fragility in

younger firms not only decreases but it leads to a negative impact on the performance of the firm. Therefore, the hypothesis **H2** is accepted as indicated from the results shown in Table 4.

We further find a positive impact of age on the performances of firms. The interaction dummy variable of age and fragility, in this case, describes the negative impact on the performances of firms, which shows the destruction of performance due to fragility. Fragility converts the positive impact of younger age firms on performance into a negative impact. Further, this model describes that fragility not only volatile the accounting performance but it leads to the decline in the market performance of the firm as well.

Results of Table 5 show that the significance of the beta coefficient of larger size firms captures the change in performance measure variable, and rejects the null hypothesis, and ensures the acceptance of alternative one (**H3**) that there is a positive relationship between the larger firms, and the performance. Unlike the case of younger firms, fragility does not destroy the performance of larger firms. The interaction dummy variable of large size and fragility shows the negative beta coefficient but is insignificant. It means that there is no effect of fragility on the performance of larger firms.

Table 5: Results of POLS of Larger and Smaller Firms

Variables	DV: ROA Model 9	DV: TQ Model 10	DV: ROA Model 11	DV: TQ Model 12
	<i>Larger Firms</i>		<i>Smaller Firms</i>	
C	0.47642*** (0.128)	0.473*** (0.132)	1.640*** (0.136)	1.653*** (0.136)
SZ	0.037*** (0.014)	0.0382*** (0.014)	<-0.001*** (<0.001)	<-0.001*** (<0.001)
GR	0.007* (0.004)	0.008* (0.004)	-0.006 (0.004)	-0.011** (0.005)
AC	0.338*** (0.0418)	0.358*** (0.043)	0.152*** (0.048)	0.155*** (0.048)
CF	<0.001*** (0.000)	<-0.001*** (0.00000)	0.001* (0.001)	0.002** (<0.001)
SZ*FFR	-0.003 (0.005)	-0.006 (0.005)	-0.555*** (0.119)	-0.556*** (0.120)
Adj. R²	0.194	0.211	0.144	0.147
F- Statistic	1.094	1.089	0.952	0.924

***, **, * the significance of results at 1%, 5%, and 10% level of significance, respectively.

Estimation results of the model10 show that the size of the larger firms has also a positive impact on the market performance of the firms. The interaction dummy variable of large size and fragility is insignificant which means that the market performance of larger firms is not affected by the fragility. Results in Model 11 describe that with the decrease in the size of firms, the performance also decreases. The interaction dummy variable of small size and fragility shows the significant negative beta coefficient. It means that the market performance of the smaller firms will decline drastically in the presence of fragility.

5. CONCLUSION

Financial Fragility means the unavailability of finance, which leads to less investment, and low productivity as well as low profitability. The present study investigates phenomena regarding

the destruction of firm performance resulting in financial fragility. The analysis of the study shows that fragility has a negative impact on firms' performance. Financial fragility shows the negative impact on the performance of the firms during 2010-2019, describing that cost of using debt is higher than the benefits. Hence, firms should reduce debt financing to improve their performance. These results follow the optimal capital structure theory that debt will destroy the value of the firm when it crosses the optimal level (Moyer et al., 2001). In contrast, the pecking order theory states that retained earning financing is better than debt financing, and debt financing is better than equity financing from the issuance of new shares (Myers, 1984).

We further find that non-fragile firms have easy access to external finance, which creates investment opportunities. Older firms are low performers than the younger firms, and the destruction of the financial fragility is found in the case of both types of firms, younger, and older. The presence of financial fragility converts the positive impact of younger firms on the performance into the negative impact, and increase the negativity of older firms with respect to accounting as well as market performance. This study results show the positive impact of size on the performance of firms in the case of large-size firms, and the negative impact of the size is reported on the firm performance for the small-size firms. Unlike the results of the interaction dummy variable of age and financial fragility, the presence of fragility n'does not destroy the performance of the firms in the case of large-size firms. But the small size firms are found more affected by the presence of financial fragility. But if the financial fragility persists continuously, then the performance of large size firm will also decline.

It is the more desirable policy for a firm to use retained earnings for financing instead of debt financing. This policy follows both, optimal capital structure, and pecking order, theories. The firm's manager should be careful to utilize the option of debt financing, although pecking order theory suggests using debt financing if retained earnings are not enough. The results of the study describe that the firms are highly leveraged, and the managers of fragile firms should reduce the debt of the firm to improve the performance.

6. Availability of Data, and Material

Data can be made available by contacting the corresponding author.

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Muhammad Munir Ahmad is a Lecturer in the Department of Commerce, Allama Iqbal Open University, Islamabad, Pakistan. He received his MS (Finance) degree from SZABIST, Islamabad, Pakistan. He is a PhD candidate (Finance) at Pir Mehar Ali Shah-University of Arid Agriculture, Rawalpindi, Pakistan. His interests involve Cost Accounting and Financial Management.



Dr. Salman Ali Qureshi is an Assistant Professor of Finance at Allama Iqbal Open University Islamabad. He got his PhD (Finance) degree from Iqra University Islamabad Campus, Pakistan. His interests involve Financial Management and Financial Econometrics.



Dr. Muhammad Bilal is a BBA Faculty Member in the Department of Business & Economics, FG Sir Syed College, Rawalpindi, Pakistan. He received his BS (CS) degree from PMAS-UAAR, Pakistan. He continued his MS/PhD study at Iqra University Islamabad Campus Pakistan where he obtained his PhD in Business Administration with a specialization in Finance. Dr. Muhammad Bilal interests involve Risk Management and Capital Budgeting in Financial Institutions.



Dr. Naveed is an Assistant Professor in the Department of Management Sciences, Qurtuba University of Science, and Information Technology, Peshawar, Pakistan. He has completed his PhD in Management Sciences from Abasyn University Peshawar. His research focuses on Corporate Governance, Corporate Finance,, and Banking.



Dr. Asif Mahmood Rana teaches at Federal Urdu University of Arts, Science & Technology, Islamabad, Pakistan. He received his MS (Management), and PhD (Management Sciences) degrees from Iqra University Islamabad Campus, Pakistan. His research involves Strategic Management, Organization Development, International Management, Qualitative Research, Human Resource Management.



A Soft Switching DC-Link Quasi Resonant Three-Phase Inverter for AC Servo-Motor Drive Applications

Ali S. Alghamdi^{1*}, Khairy Sayed², Ahmed G. Abokhalil^{1,3},
Ahmed Bilal Awan⁴, Mohamed A. Zohdy⁵

¹ Department of Electrical Engineering, College of Engineering, Majmaah University, Almajmaah 11952, SAUDI ARABIA.

² Department of Electrical Engineering, Sohag University Sohag, EGYPT.

³ Department of Electrical Engineering, Assuit University, Assuit, EGYPT.

⁴ Department of Electrical and Computer Engineering, College of Engineering and Information Technology, Ajman University, Ajman, UNITED ARAB EMIRATES.

⁵ Electrical and Computer Engineering Department, School of Engineering and Computer Science, Oakland University, Rochester, Rochester, MI 48309, USA.

*Corresponding Author (Tel: +966(16)404-2568 Email: AAlghamdi@mu.edu.sa).

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Abstract

This paper presents a soft-switching circuit of a three-phase inverter for servomotor driver. The soft switching is achieved using an auxiliary quasi-resonant circuit on the DC link. The principle of operation and design steps are described in details. Soft-switching operation condition is validated in this circuit by means of simulations and experimental work. A prototype of 3-kW inverter is implemented and tested. The conductive noise is measured for the proposed AC servo motor drive and compared with that of conventional hard-switched inverter. The power loss analyses are carried out to verify the effectiveness of the proposed inverter.

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1. Introduction

AC servo motors or Permanent Magnet Synchronous Motors (PMSM) has numerous advantages over induction motor such as compact size, better efficiency, lighter weight, no slip,

and fast acceleration [1-2]. As a result, these motors are usually utilized in speed or position controlled drives in high performance applications such as robots, CNC machines, and etc. Three-Phase Inverters operating at higher switching frequencies have several applications in power-electronic devices, like ac power sources, active-power filters, motor drives, distributed generation (DG) systems and uninterruptible power supplies (UPS). The major motive to augment switching frequency is to reduce passive components' size and weight and the composition of signals with higher-order harmonic [3]–[4]. Conversely, operation at higher-switching frequency increases the electromagnetic interference and switching loss. Several works have been focused on applying different methods to minimize the switching losses in voltage-fed inverters, using passive or active auxiliary resonant circuits. The frequency of switching has to be increased for maximizing the filtering components' sizes and reducing audio noises. However, higher switching frequency for inverters with hard switching, results in increasing switching losses. This eventually augments sizes of heat sinks and snubber circuits. Moreover, radio-frequency interference reproduces, and overall efficiency is reduced [5]. Hence, applying soft-switching techniques is essential to cope with these issues, [6]–[8]. The technology of soft-switching is exceedingly used on power electronic circuits for diminishing circuit losses and noise efficiently by controlling the semiconductor device under zero-voltage and/or zero current soft switching (ZVS/ZCS) commutation. For these reasons, soft-switching is the most promising candidate for the next development of inverter technology. One class of soft-switching inverters is the quasi-resonant (QR) dc-link inverters that can be regulated using pulse-width modulation (PWM) technique [9]–[14]. The configuration of these inverters is featured by using a series switch (dc-link switch) to separate the inverter dc-link from the input power supply while a resonant capacitor is positioned in parallel with the inverter dc-link. The QR inverter scheme generates zero-voltage instants in the DC-link at controllable periods that can be synchronized with typical PWM switching action, thus assuring a zero-voltage soft switching (ZVS) operation of inverter semiconductor devices. In different words, the dc-link power switch is opened when a change in the status of the inverter power switches is required and the discharge of the resonance-capacitor takes place through an additional circuit. Consequently, the inverter's semiconductor switches status can be altered under ZVS condition. To discharge or charge the capacitor of dc-link, usually, two or more switches are required for the auxiliary circuit. Since all QR dc-link (DCL) inverters need a power switch in the essential power flow path and they are appropriate for low and medium power applications.

Recently, the power conversion circuitry topologies are developed using the modern semiconductor devices like IGBTs and MOSFETs. However, rise in inverter switching frequency becomes indispensable in order to improve its controllability, to reduce undesired acoustic sound, and to downsize the equipment [15-16]. However, in conventional hard switching inverters, the power losses resulting from switching of power semiconductor devices as well as EMI noise levels become larger. In addition, in the power converter / inverter which is utilized for variable speed servo motor drives, the new problems are breaking out due to high dv/dt such as the high-

frequency leakage current which circulates into the grounded parts through the stray capacitance between the stator windings and the frame of the motor, the induced voltage on motor shaft and the bearing current. On this account, the inverter AC servo drive installations with the high speed power semiconductor devices such as IGBTs, MOSFETs etc. tend to have these problems more and more obviously.

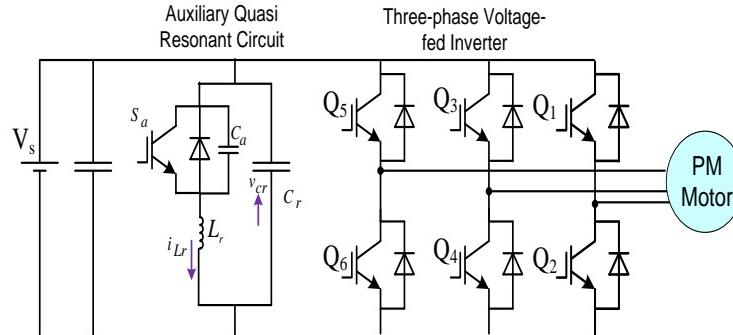


Figure 1: Proposed soft switching inverter for AC servo motor drive using QR dc link snubbers.

For tackling the aforementioned problems, the soft switching techniques are proposed for power conversion circuits. These techniques make the semiconductor devices work under the zero current or zero voltage mode transitions. Generally, based on auxiliary circuitry location, the three-phase voltage source soft-switching inverters are classified into dc-bus-side topologies [17]–[21] and load-side topologies [22]–[27]. The operation at optimal efficiency for a given performance is one of the challenges facing developers of servo-motor applications. For this reason, power loss calculation of power converters has been considered due to the impact of various PWM techniques used for vector-controlled servo drives [28]–[31] and direct torque controlled variable-speed drives [32]. However, this design depends strongly on thermal performance and power losses calculation. Both of these key factors decide the reliability and power density of power converters [33].

This paper deals with the three-phase soft switching inverter using the QR DC bus snubbers for the AC servo motor drives. Moreover, it presents the evaluations for the soft-switched QR snubber circuit. The conductive noise of the studied QR snubber assisted voltage-fed inverter is measured for AC servo motor drive and compared with that of the conventional hard switched three-phase inverter.

2. Circuit Topology

The control system of AC-servo-motor drive is described in Figure 1. This configuration is based on three phase voltage soft switching inverter assisted by utilizing QR DC-link snubbers. Figure 1 illustrates the main parts of a PWM servo motor drive. The input three-phase voltage is rectified and filtered to produce a DC-link voltage for inverter stage of drive. The stator winding inductance of the servo motor plays as a low-pass filter for the studied inverter. The inverter consists of three pairs of IGBT semiconductor switches with associated reverse conducting diodes. Each pair of IGBT switches enables the output voltage for each phase of the motor. However the inverter consists of three legs, each leg consists of one pair of IGBT semiconductor switches. All are

driven with the aid of the control electronics to produce a higher frequency gate drive pulses. An auxiliary circuit is inserted between the DC-rectified input and the DC-bus of the three-phase inverter. The suggested auxiliary circuit is utilized to enable zero-voltage duration of the DC-link at the desirable switching instant. Thus the corresponding semiconductor devices in three-bridge legs can achieve ZVS condition.

The soft switching operation of inverter is based on the loss-less capacitors using LC quasi-resonance phenomenon. Employing this phenomenon, the DC bus line voltage of quasi-resonance capacitor C_r that is associated in parallel to auxiliary switch is brought down to the zero voltage. Consequently, the power switches of inverter bridge-arms can realize ZVS/ZCS turning-on and ZVS turning-off. This circuit topology is composed with the switch S_{cl} of the circuit which clamps the DC-link at the DC input voltage V_s , the auxiliary switches S_{a1} and S_{a2} for transferring resonant mode, the QR inductance L_r , the resonant capacitor C_a connected in parallel to the switch S_{a2} and the resonant capacitor C_r connected in parallel to inverter switch S_{inv} as depicted in Figure. 2.

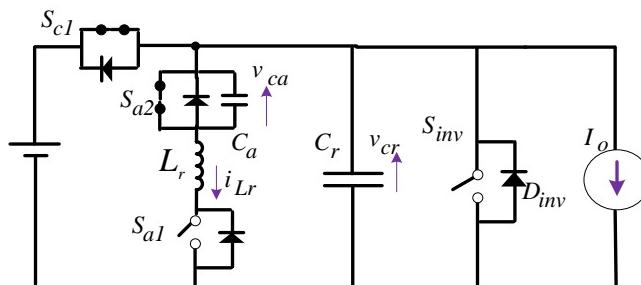


Figure 2: Auxiliary QR dc-link snubber equivalent circuit.

3. Theory of Operation

The studied ZVT power converter has special advantages including the operation of main IGBTs and diodes with ZVS and a reduced current and voltage stresses on the devices, namely the same as their PWM counterpart. Additional key advantages are simple circuit topology, the utilization of the same resonance tank for both upper and lower branches, and fully utilizing all diodes built-in power IGBTs, thus reducing the total component count and cost. These are very desirable features for high power high frequency converters, where power IGBTs are used. This makes the studied converter particularly beneficial for servo motor drives, which require multi-phase full-bridge ac inverters. The consequent theoretical analysis and efficiency calculations are supported by simulation. The ZVT-cell can also be modified to provide ZVS for all chopping and commutating switches of a servo motor drive.

This model is utilized in order to explain the operation modes of the QR DC-link circuit. Figure 2 shows the equivalent circuit of single-phase arm. The operation waveforms are shown in Figure 3. The related equivalent circuits of all modes are represented in Figure 4.

Mode 0 (- t_0): Both the auxiliary (S_{a2}) and the voltage clamps switch (S_{cl}) are in operation. The current is flowing to the load.

Mode 1 (t_0-t_1): The switching gate pulse is applied to the inverter main power switches. Switch S_{a1} is turned on at the ZCS condition. Therefore, the current i_{Lr} of the QR inductor is boosted

enough to pull down the voltage across the main QR capacitor to zero volt. This is considered as an energy storage interval (t_0-t_1) which is required for storing resonant energy in the resonant inductor L_r to assure that the voltage on resonant link does decrease down to zero, during the ramp down interval. The energy storage interval begins with turning-on the auxiliary switch S_{a1} . Then,

$$i_L(t) = \frac{V_{in}}{L_r}(t - t_0) \quad (1).$$

This interval (energy storage interval) terminates when current in resonant inductor reaches the maximum value $i_L(t_1)$. Then,

$$i_L(t_1) = \frac{V_{in}}{Z_r} = i_L(t)_{\max} \quad (2).$$

The period of the energy storing interval is

$$\Delta t_1 = \frac{\pi}{2\omega_r} \quad (3).$$

Mode 2 (t_1-t_2): When the current in QR inductor i_{Lr} reaches to the initial QR current I_{boost1} , both S_{a2} and S_{cl} are turned off under ZVS condition, while quasi-resonance begins with L_r , C_r and C_a .

The resonant current in this mode is given by

$$i_{Lr} = I_o + \frac{V_s}{Z_0}(t - t_1) \quad (4).$$

Interval 2 starts when the diode D stops conduction. The elements L_r and C_r represent a series resonance circuit. The corresponding differential equations are

$$i_{Lr}(t) = C_r \frac{dV_{cr}}{dt} + C_a \frac{dV_{ca}}{dt} \quad (5),$$

$$L_r \frac{di_{Lr}(t)}{dt} = V_s - v_{cr}(t) \quad (6),$$

with initial conditions $i_{Lr}(0) = I_m$ and $v_c(0) = -V_o$.

The solutions for the above equations are

$$i_{Lr}(t) = I_o + \frac{V_s + V_o}{Z_0} \sin(\omega_o t) \quad (7),$$

$$v_{cr}(t) = V_s - (V_s + V_o) \cos(\omega_o t) \quad (8),$$

$$v_{Lr}(t) = (V_s + V_o) \cos(\omega_o t) \quad (9).$$

Mode 3 (t_2-t_3): When the voltage v_{cr} across the main capacitor is brought to zero, the reverse diode which is parallel to switch S_{inv} conducts and then S_{inv} turns on at ZVS/ZCS condition. The current in inductor is linearly decreasing. This mode ends when $I_{Lr}(t)$ reaches to zero.

$$i_{Lr}(t) = -\frac{V_s}{L_r}(t-t_2) + I_o \quad (10).$$

Mode 4 (t_3-t_4): The current through QR inductor i_{Lr} starts increasing in the opposite direction and it raises voltage of capacitor to source DC voltage V_s . During this period, the auxiliary switch S_{a1} is turning-off achieving ZVS-ZCS commutation condition. In the time interval between t_3 and t_4 , the load current is supplied from L_r and by electric charge stored in C_r in a QR manner. The resonant current in the inductor decreases to zero at time t_4 . The inductor current and capacitor voltage for this time interval are

$$i_{Lr}(t) = I_o + i_{cr}(t) = I_o + \frac{V_s}{Z_0} \sin(\omega_o t) \quad (11),$$

$$v_{cr}(t) = -V_s \cos(\omega_o t) \quad (12),$$

where $Z_o = \sqrt{L_r/C_r}$ and $\omega_o = 1/\sqrt{L_r C_r}$. Equation (11) shows that the inductor current only returns to zero if $I_o < V_s/Z_o$, otherwise it commutes with non-zero current flow.

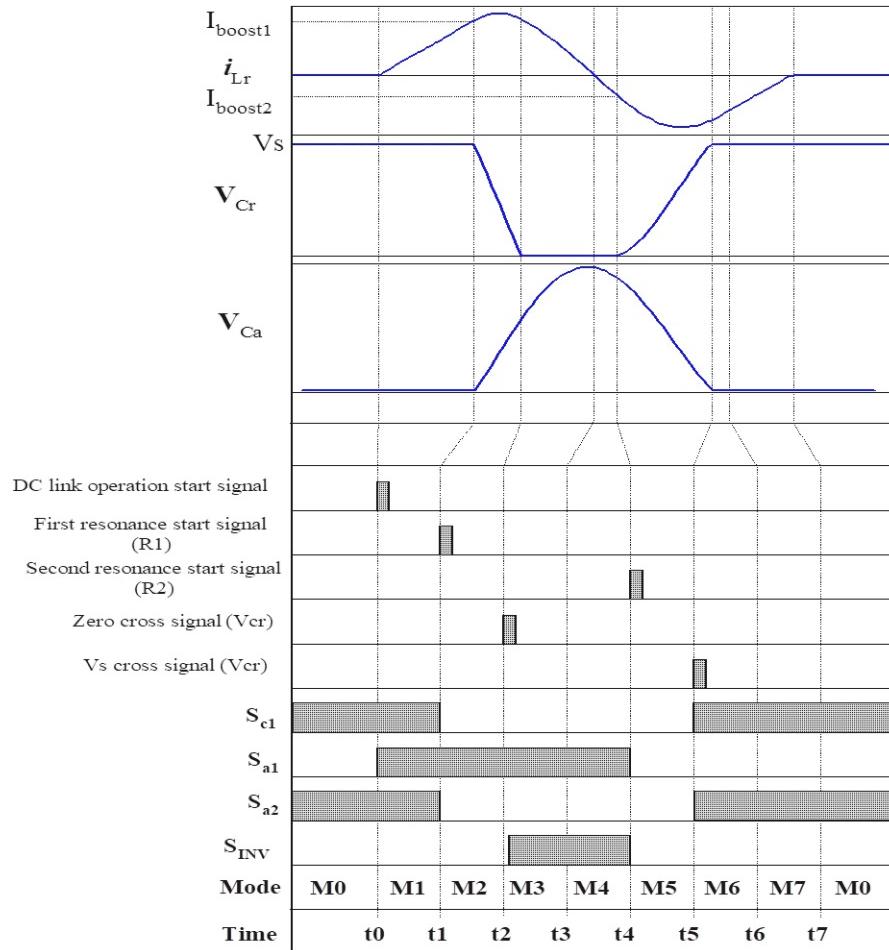


Figure 3: Switching patterns and the operation waveforms of the QR DC link snubber.

Mode 5 (t_4-t_5): As soon as the inductor current i_{Lr} reaches to the second quasi-resonance value I_{boost2} , the switch S_{INV} turns off under ZVS condition, and starting the quasi-resonance formed by L_r, C_r and C_a .

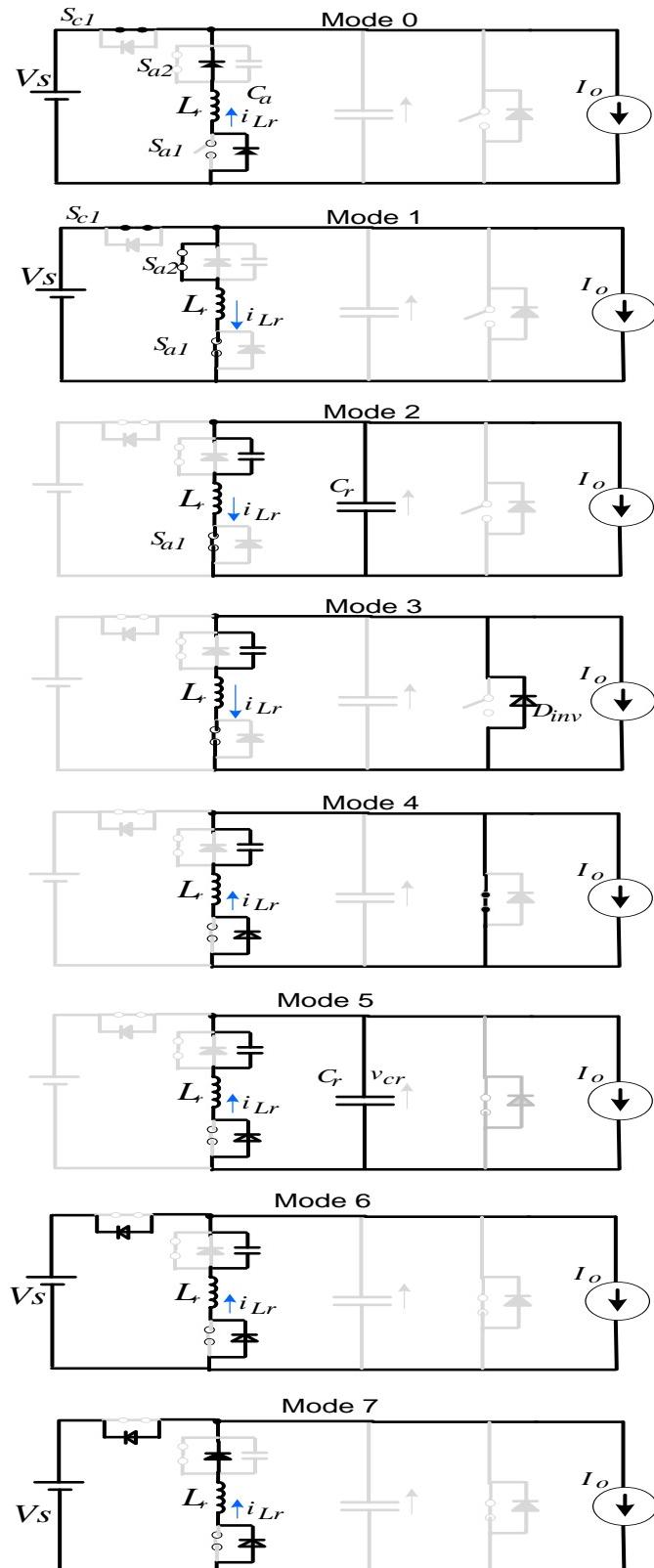


Figure 4: Equivalent circuits and switching mode transitions.

The capacitor voltage $V_{cr}(t)$ rises linearly from 0 to V_s and is clamped to V_s . The corresponding equations in this time interval are expressed as

$$i_{Lr}(t) = I_4 + \frac{V_s + V_0}{Z_0} \sin(\omega_o t) \quad (13),$$

$$v_{cr}(t_5) = V_s \quad (14),$$

$$v_{cr}(t) = -V_s \cos(\omega_o t) + V_s \quad (15),$$

where I_4 is the load after the switching state.

Mode 6 (t_5-t_6): The main QR voltage across the capacitor v_{cr} reaches to the dc voltage source voltage V_s . At this time, the diode which is connected to the voltage clamp switch in back-to-back conducts and both the switches S_{c1} and S_{a1} turn on at the ZVS/ZCS condition.

Mode 7 (t_6-t_7): The inductor QR current flows through diode anti-parallel to S_{c1} and regenerated to the DC voltage source V_s . The gate signal of all the semiconductor switches and the operation waveforms for current and voltage of the QR snubber circuit are shown in Figure 3. As soon as the capacitor voltage $v_{cr}(t)$ reaches $-V_o$ at $t=t_6$, the diode parallel to S_{a2} starts conduction. This interval ends when the switch S_{a1} is closed again to start the next cycle. The duration of this interval is T_7 which is equal to t_6-t_7 .

4. Experimental Implementation

The configuration and specifications of the experimental system are shown in Figure 5 and Table 1, respectively. In this system, the operation of the QR DC link snubber of the voltage-fed three-phase inverter is validated, and the conductive noise of the system is measured. Both the on time and off time have about 2 μ sec delays. As a result, the switching timing of the main circuit is delayed if the switching pattern indicated in Figure 3 is applied. Therefore, the first QR start signal is used as a trigger signal and the switching timing of the main switches are decided by 74LS123.

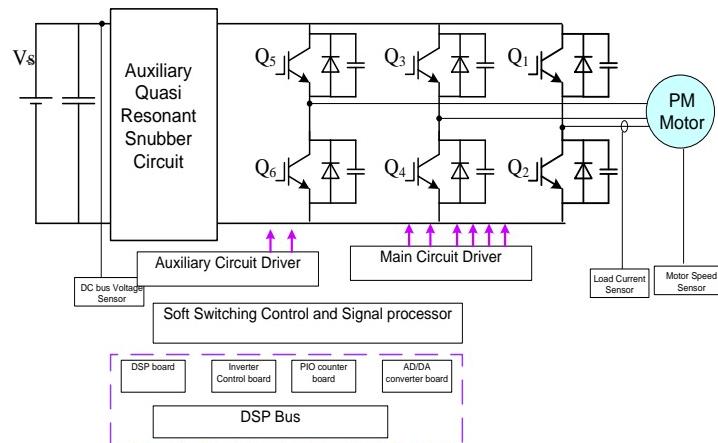


Figure 5: Experimental setup system.

For the conductive noise measurement, the hard and the hard switching are compared under the condition of the same peak load current value. In the experimental system, the operation of resonant DC link snubber of voltage-fed three phase inverter is validated, and conductive noise of the system is measured. Figure 6 indicates waveforms of operation of snubber circuit. The voltage of the main QR capacitor is pulled down to zero voltage and pulled up to the DC bus-line voltage V_s , and all the main inverter switches achieved the ZVS during this DC bus-line notch mode period. Figure 7 indicates the U-phase load current wave.

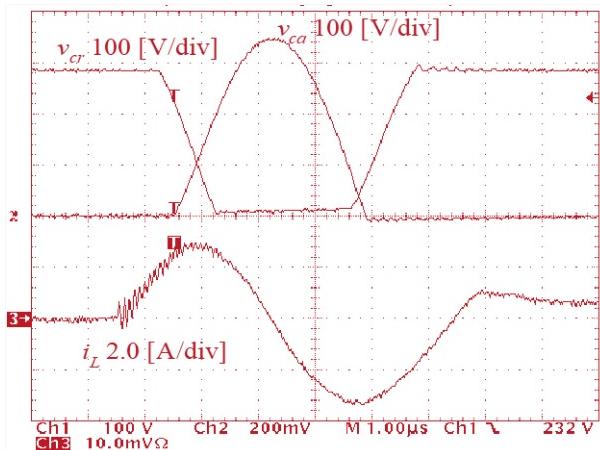


Figure 6: Operation waveforms of QR dc-link snubber circuit.

Table 1: Experimental Parameters.

Power source	DC power source voltage	V_s	280 [V]
Auxiliary resonant snubber circuit	Main resonant capacitor	C_r	10[nF]
	Auxiliary resonant capacitor Cs	C_a	10[nF]
	Resonant inductor	L_r	101[μH]
	Power switches devices IGBT CM75DY-12H	S_c, S_{a1}, S_{a2}	Maximum rate Ic=75[A], Vces=600 [V]
	Voltage surge suppression snubber	C_s	0.22[mF]
PM motor (BM0230)	Snubber diode	D_s	USR30P12
	Snubber resistance	R_s	20[Ω]
	Leakage inductance	L_{load}	10[mH]
	Stator resistance	R_{load}	7.5[Ω]
Main circuit	Number of poles	P	8
	Rated current	I_{max}	1.4[A] , rms
Sampling frequency	Power switching device (PM50RSA060)	$S \approx S_{w2}$	Maximum rate Ic=50[A], Vces=600[V]
		T_s	10[kHz]

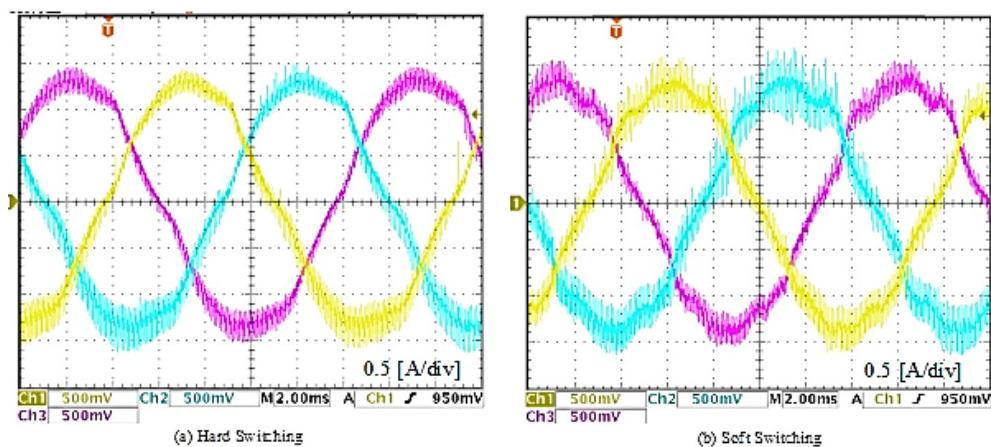


Figure 7: Three-phase load current.

5. Power Loss Analysis

The investigated losses in a motor drive converter are the losses resulting from the power semiconductors switches (IGBTs and Diodes) and the passive circuit components (inductors and capacitors). As well known, the power losses during operation of the power semiconductor devices can be categorized into switching losses and conduction losses. The losses can be estimated where an ideal three-phase sinusoidal Pulse Width Modulated (PWM) voltage is supposed. The distribution of losses calculated under condition of 3-kW output power is illustrated in Figure 8. The efficiencies of ZVS soft-switched and hard-switched inverters are compared as illustrated in Figure 9.



Figure 8. Loss calculation

The losses in the inductor filter are about 220 W. While the resonant inductor losses are 28.5 W and decreased by using soft-switching to 14 W. The losses in the auxiliary switches are reduced from 46 W to 30 W. The losses in the main switches are decreased from 82 W to 50.2 W. However, the total losses are decreased from 367.5 W to about 314 W. The circuit efficiency is improved from 87.1% to 89.5%.

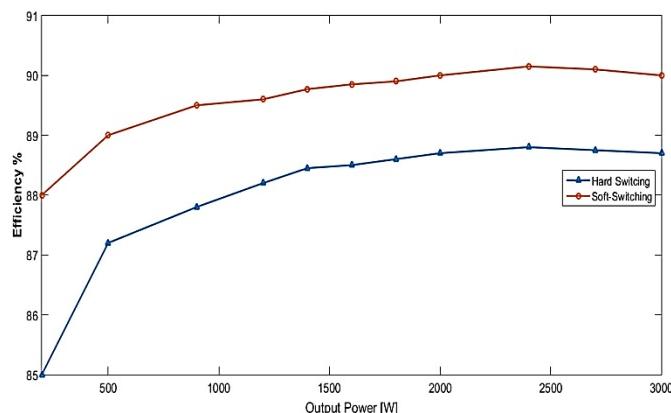


Figure 9: Efficiency curve.

The efficiency is measured using a power analyzer in laboratory. Figure 9 shows that use of soft-switching technique helps to improve the circuit efficiency. For the IGBTs, turning-on and turning-off and on-state conduction losses are deliberated, while the reverse blocking losses are supposed negligible. Likewise, for the diodes, on-state conduction and turning-on switching losses are taken into account, but the turning-on losses are ignored due to a presumed fast diode turning-on process. However, the goal of this clarification is only to provide an idea regarding the losses valuation.

6. Conclusion

A small scale PM motor drives circuit topology of an auxiliary active DC link QR snubber was presented. By using the proposed soft-switching scheme, a good performance of servo motor drive is obtained. The measured and simulated results show that a good performance of soft-switched inverter is obtained. The theory of operation is explained using operation modes and switching

equivalent circuits. The experimental waveforms were introduced and discussed for the practical perspective. The results show that the efficiency of is improved using auxiliary switches in the PM motor drive.

7. Availability of Data and Material

Data can be made available by contacting the corresponding author.

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Dr. Ali S. Alghamdi is an Assistant Professor and Acting Chair, the Department of Electrical Engineering, the College of Engineering, Majmaah University, Saudi Arabia. He received his dual B.S. degree (with high honors) in Computer and Electrical Engineering from Lawrence Technological University, Southfield, Michigan, USA, respectively, and an MSc in Electrical and Computer Engineering from Lawrence Technological University, Southfield, Michigan, USA. He received a Ph.D. in Electrical and Computer Engineering from Oakland University, Rochester, Michigan, USA. His research interests include Statistical Digital Signal Processing, Communication Systems, Adaptive Filter, Modern Control in Power System, Optoelectronics Nano-materials in Renewable Energy, and Wireless Sensor Network Innovation.



Dr. Khairy Sayed is an Associate Professor in the Department of Electrical Engineering, Sohag University, Egypt. He received his B.S. degree in Electrical Power and Machines from Assiut University, Assiut, Egypt. He got a Master's degree at the Electrical Energy Saving Research Center, Graduate School of Electrical Engineering, Kyungnam University, Masan, Korea. He got a PHD degree from Assiut University. His research interests include Renewable Energy, Solar PV, Wind Energy, Fuel cell, utility interactive power conditioner for renewable energy sources. Soft switching DC-DC power converter typologies. Smart Energy Grids, Protection, and Control of Smart Microgrids.



Dr. Ahmed G. Abo-Khalil is an Associate Professor with the Department of Electrical Engineering, Majmaah University, Almajmaah, Saudi Arabia. He received a Bachelor's and M.Sc. degrees in Engineering from Assiut University, Egypt, and a Ph.D. degree from the School of Electrical and Computer Engineering, Yeungnam University, South Korea. In 2008, he joined the Rensselaer Polytechnic Institute, NY, USA, as a Postdoctoral Researcher, and worked on a Renewable Energy Project. For 2009-2010, he was a Postdoctoral Research Fellow with the Korean Institute of Energy Research, Daejeon, South Korea, working on Photovoltaic Power Conversion Systems. He was an Assistant Professor at Assiut University.



Dr. Ahmed Bilal Awan is with the Electrical and Computer Engineering Department, College of Engineering and Information Technology, Ajman University, Ajman, United Arab Emirates. He received a B.Sc. degree in Electrical Engineering from the University of Engineering and Technology (UET), Lahore, Pakistan, a master's degree from the École Supérieure d'Electricité SUPELEC, Paris, France, and a Ph.D. degree from the Groupe de Recherche en Electronique et en Electrotechnique de Nancy (GREEN), Institut National Polytechnique de Lorraine (INPL), Nancy, France. His research interests include Stability Investigation of the Distributed Electrical Systems and Switching Converters.



Professor Dr. Mohamed Zohdy works at Oakland University, Michigan, USA. He received his B.Sc. degree in Electrical Engineering, Cairo University, Egypt. He received his M.Sc. and Ph.D. degrees in Electrical Engineering, University of Waterloo, Canada. His interests are Control and Soft Computing.



Design and Implementation of Optimized LDPC for SDR Applications

D. Sahaya Lenin^{1*} and Himanshu Shekhar¹

¹ Department of Electronics and Communication Engineering, Hindustan Institute of Technology and Science, Chennai, INDIA.

*Corresponding Author (Email: dsahayal@hindustanuniv.ac.in).

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Parity generation;
optimized LDPC.

Abstract

LDPC is a promising error correction protocol, which is widely useful for low-end wireless protocol standards. This lightweight protocol mechanism is suitable for basic SDR applications. The same is not true for high-end wireless communication due to its limitations. Since technological scaling on its own is insufficient to satisfy today's SDR architectures with these wireless standards. Hence by reducing the decoding complexity and by increasing capacity performance. We use this Low-Density Parity-Check codes in SDR based wireless communication platform. The major limitation of conventional LDPC code is high latency and power consumption with top design complexity. To overcome such a problem, the optimized LDPC encoding and decoding are proposed with less lag and power consumption without degrading the performance of the conventional design. The proposed model offers less hardware complexity used in telecommunication applications. This methodology is implemented and synthesized using Xilinx ISE tool.

Disciplinary: Electronics and Communication Engineering.

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1. Introduction

Software-defined radio (SDR) is used in several domains but primarily in the communication market. Major applications of this technology are Mobile communication, Local area wireless networks, Personal area networks and Remote broadcasting. We refer to applications where it is beneficial to have the ability to modify a modulation and encoding scheme. SDRs also outperform conventional hardware-only radios in these respects, due to their quick adaption of operations as per the environment requirement on the fly through software. The technological advancement in

the field of high-speed analog to digital converters (ADCs) and high-end Field Programmable Gate Arrays (FPGAs) have attracted research over SDRs in recent days. The SDR is a complicated tool that performs many complex tasks simultaneously to enable the smooth transmission and reception of data over the communication field. An interdependent sequence of operations that collect information in the transmitter end is usually part of a digital communication network.

It is sent to the receiver as prior information for processing and decoding without error. The reconstituted version of the original information signal may be speech, music or video. The error between the reconstituted or decoded signal and the original signal should be very small in all senses. Methods like quantization are utilized to interpret the information signal in binary form. This encoding/ decoding concept is vital in all forms of error-free digital communication platforms. The proposed method describes one such method in the SDR domain. This methodology proves to be the power-optimized algorithm, which is the main constraints of the applications evolved over SDR architectures.

The transmitter digitally processes the information in binary code, which is then converted into an electromagnetic sinusoidal waveform. Its physical characteristics include signal amplitude, carrier frequency and phase. On the other end of the communication scenario, receiver evaluates accurately the features of the intercepted modulated waveform, which transmitted through a potentially twisted and distortion-filled medium. The input of the transmitter and the output of the receiver derives a digital source and digital sink. Figure 1 shows the source and destination of the digital communication network's basic building blocks.

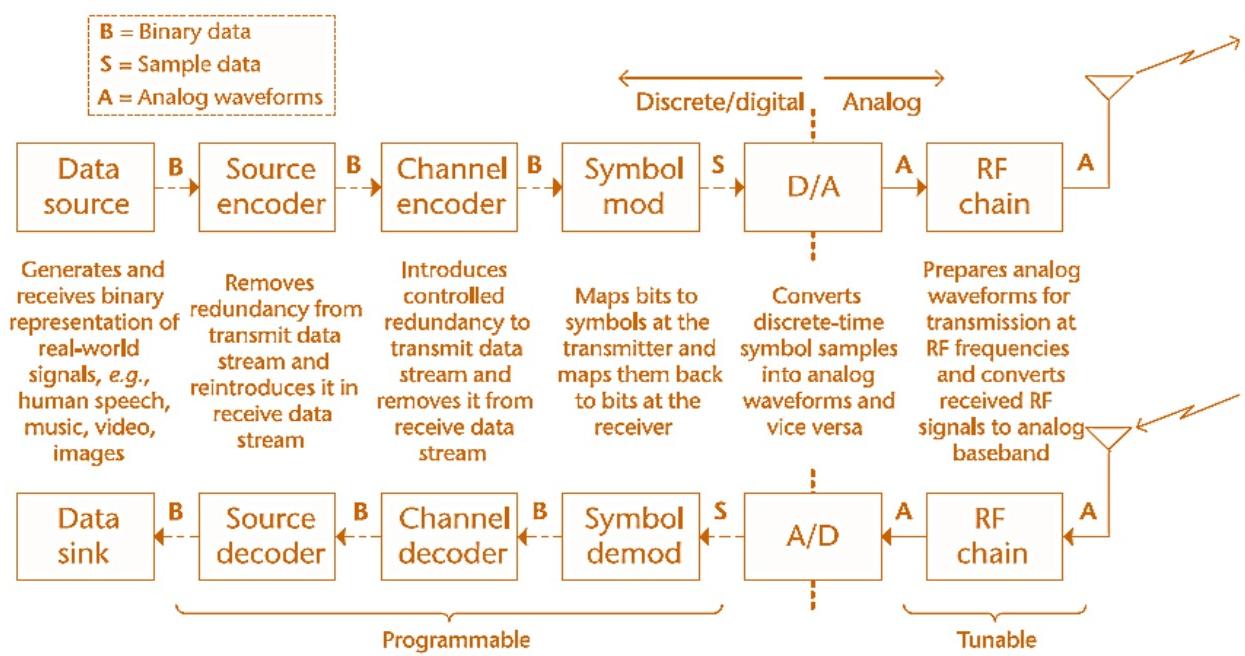


Figure 1: SDR general block diagram

The conversion of the source data into binary data then to symbol and vice versa is the complicated phases of the digital communication process. The same is taken care of by the processing elements mostly by DSP algorithms or by using the processing elements of reconfigurable FPGAs. The proposed power efficient algorithm is executed here in Xilinx platform.

When binary information is introduced into the sender, the first function is to delete all redundant/repeated binary patterns from the data so that transmission capacity is enhanced. This is done with the root block encoder that is programmed to remove all redundancy information. The source decoder reintroduces redundancy in the receiver to restore the binary information in its original form when the redundancy is removed from the binary data of the transmitter. To protect the information stream from possible errors that are introduced over a noisy channel during the transmission process, a channels encoder is used to add a fixed amount of redundant data.

A channel decoder eliminates this controlled redundancy, and binary information is returned to its original form. The next step is to convert binary data into specific electromagnetic waveform properties such as amplitude, frequency and phase. This is achieved using a modulation projection method. The receiver also transforms the electromagnetic waveform into a binary picture from the demodulation process. The discrete block samples are eventually re-sampled and turned into an analog waveform baseband with a digital to analog converter before being passed on to the RF frequency through the front-end communications network radio frequencies. The reverse is performed on the receiver when, before sampling and processing by an analog-to-digital converter, the intercepted analog signal is transformed by RFFE to the baseband frequency.

Low-density parity codes have shown a significant error beyond the Shannon limit in the output correction. Reasonable correction efficiency ensures secure and efficient communication. But the LDPC decoding algorithm must run effectively to satisfy the cost, time, power, and bandwidth requirements of the target applications. The generated codes should also meet the output error rate criteria for these applications. Much research work has been carried out on the design development and implementation of this LDPC code since its rediscovery. The LDPC codes can be designed in a full room using parameters like diameter, rate and length. The target focus of this research is to fix the standard framework to produce efficient LDPC codes. Developing the system with better performances, error-free and easy implementable nature at a specific rate and length is the prime focus point here. Current build methods were somehow restricting or compromising one or other factors of requirements. Based on good performance and hardware compliance, construction methods over a broad spectrum of frequencies and longitudes need to be developed.

The development and implementation of the LDPC hardware code depend on the LDPC layout target and are as diverse as the LDPC archives. The variables used in this algorithm: decoding estimates, network interconnection points, number of nodes, memory dimensions, numbers of bits of quantization and decoding delay. Day-to-day communications such as cloud networks, television broadcasting/weather digital satellite forecasting, internet, high-speed modems, wireless mobile phones are instances of automated communication systems symbolizing the transfer of information from the source to the insecure environment, namely space/air. These environments are unstable, and errors can occur during transmission. The original information is encoded to increase error correction capability.

2. Literature Review

The work [1], through NRI, the information is encoded at the transmitter module, which is determined precisely by human-based channel communication. The FPGA improves the existing signals at the receiver module. [2] describes the LDPC encoding techniques through an approximate lower triangulation model. By solving the triangular factorization and sparse equation, this technique computes the parity check symbols. [3] describes the LDPC decoder with less power. For calculating the count of iteration until the end of the LDPC decoding, the SNR evaluation value is utilized.

In [4], the encoding scheme method and soft-decision iterative decoding are described. In [5], the encoder in LDPC is substituted by the proposed encoding method by avoiding the transitions is described. This method offers less power. In [6], protograph LDPC codes over space-time block code over Rayleigh fading channels are described. Also, the comparison is made for bit error rates and decoding thresholds of two-protograph codes, namely accumulated-repeat-by-4-jagged-accumulate and accumulated-repeat-by-4-jagged-accumulate.

In [7], the architecture of hybrid coding is described. This coding is made up of optimized protograph LDPC and modified variable run-length limited codes to minimize the occurrence of error. In [8] low routing parallel decoder and iterative decoder convergence are described. To reduce the logic area and interconnect complexity is bit serial-parallel architecture is used. [9] describes the build of multiple rate LDPC codes, a modified progressive edge growth algorithm is too described. This technique is also named as multi-rate progressive edge growth, and this minimizes the realization complexity.

In [10], the hardware architecture of parallel decoding and encoding approach for polar codes concatenation with LDPC is described. This approach reduces the decoding delay. In [11], IEEE 802.16e based decoder is described. This method provides less latency. In [12], a variable length coding approach utilizing LDPC is described for lossy compression. This approach is made up of lossless compression module and vector quantization module.

In [13-15], optimization techniques for parallel LDPC decoder is described. It contains fully coalesced memory access, multi-stream concurrent kernel execution and asynchronous data transfer for new GPU structure is utilized. In conventional LDPC encoding and decoding, a parallel, parallel encoding and decoding Algorithm with reduced latency and power consumption is presented with long latency and high power to overcome these disadvantages.

3. Method

3.1 LDPC Code Detection

General-purpose microprocessors are employed with a high level of flexibility concerning reconfiguration and quick deployment characteristics in the SDR deployment and prototyping phase. Multipurpose Microprocessors, on the other hand, are not specialized in complex calculations and maybe power inefficient. Digital signal processors (DSP), which are specialized in

digital computing, are relatively simple to implement new digital communication modules. The processor is relatively power-efficient. DSPs, however, are not appropriate for rigorous computational procedures and can be lent. Field Gate Arrays are essential for custom digital signal processing applications since specialized algorithms can be implemented that are entirely parallel. The DSP framework facilitates the creation of new modules and FPGAs. MATLAB functions are used to generate the corresponding Verilog and VHDL codes for implementation purposes too. Moreover, simulation models and state flow charts are also perfect for extracting signal processing algorithms from specific MSP slice programs. DSP applications use many of the binary multipliers and accumulators that we may use in dedicated DSP slices.

The proposed LDPC code detection system includes mapping some word or message information to a long-word code with a one-to-one connection for every word and its related text field. This correlation is required if the same knowledge is to be recovered from the word. Traditionally, the length of the word description is taken as K , while the size of the word code is N . Therefore, the coding process provides consistency,

$$M = N - K \quad (1)$$

Additional elements in any word code such as Binary codes are used in this analysis, indicating that every part of the message and code words is either 0 or 1. Besides, the coding schemes used are assumed to be hierarchical, unless otherwise specified. The message word for systematic systems is found in the code word as in equation 1, 2 shown

$$c = [M \ p] \quad (2),$$

where p is the redundant bit length M is the message length vector of the encoder. This indicates the amount of redundancy that the code has introduced, thus

$$R = K/N = (N - M)/N \quad (3).$$

LDPC codes are linear block codes, fully defined in the matrix of code known as the matrix of parity checks for the code. In the case of binaries, the C-code (N, K) is officially specified in the Galois binary field of all N -tuples as a K -sized subspace. For linear block code, the parity-check matrix is binary $M = N$ matrix H so that C is zero-space H . You may also define the linear block code as a binary K / N generator matrix G , a matrix with a row space equal to C . It is clear from these definitions that for every $C \in C$

$$c = mG \quad (4)$$

$$cHT = 0 \quad (5)$$

where the two operations are performed under arithmetic modulo-2, LDPC codes are linear block codes with a sparse parity check matrix, as seen in Equations (4), and (5). The LDPC matrix H has a higher non-zero compared with zero inputs. LDPC codes have a higher parity check matrix.

3.2 LDPC Representation

Although a sparse matrix determines an LDPC code, Tanner graph, a two-part graph, can be used to represent the code. A Tanner two-part graph is a graph with nodes divided into two sets that connect each node to a node in the other set. The two nodes in a Tanner graph, known as check nodes and factor nodes, describe rows and columns. Figure 2 displays a matrix with a matching Tanner graph for the parity check. If and only if $H=a$, then $b = 1$. The check network a is equipped to the variable node Search Nodes f_0 , while b to F_5 reflect the matrix's six rows, and columns $V_0 \dots V_{11}$. The same number of elements in each check node corresponds to the mass of the row. The number of edges in each reference node corresponds to the weight of the column. In this case, the weights are four and two in row and column, respectively. A loop for parity checking in a matrix is generated through a complete path through 1 input with alternating movements between rows and columns. The cycle length is a function of the number of edges moving in the direction. In the graph, a cycle of six is shown in bold. In a Tanner graph or matrix for parity search, the smallest cycle is called its girth. The least girth possible is four. A bipartite graph has a minimum length cycle of four and even cycle lengths.

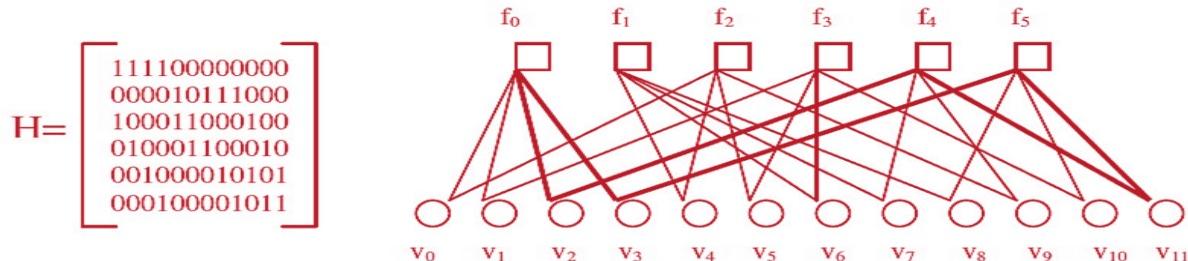


Figure 2: Parity test matrix

3.3 LDPC Encoding

The encoding process of LPDC code is achieved in the similar way for all linear systems using the LDPC representation technique briefly discussed above. For the given or known H matrix, the generator matrix G is derived from the values to check the parity errors. The encoded matrix 'c' is achieved by multiplying the generator matrix with $u = u_1 \dots u_N$ such as $c = uG$, where u is a string of bits. Note that placing H in a systematic form, $H = [PT \ IM]$, would no longer have fixed column or row weights and most likely P would be dense. The computational complexity of the proposed encoder is calculated by the density of P . A complex generator matrix requires many complex computations when combining the pattern with the data to be sent. The complexity of the encoding process is the number of operations $O(N^2)$ or, more specifically, operations $N^2 R (1-R)$ where R is code rate. The preprocessing technique over the parity-check matrix can reduce the complexity of the encoding process for specific codes. An effective encoding technique was developed to minimize encoding difficulties to $O(N)$ by rearranging the matrix for parity checks before encoding. The complexity of encoding also depends upon the code's structure (row-column interconnections). Quasi-cyclical codes are one where another codeword results in a cyclic shift of

one codeword. Thanks to the cyclic row-column ties, due to this encoding process result as linear with the code length

3.4 LDPC decoding

Decoding process of LDPC code attempts to reconstruct the received codeword c probably from the corrupted word obtained, that is y . It's accomplished with the use of matrix parity search H . The condition that $cH^T = 0$ defines the collection of parity test constraints or equations to be met in order to obtain the codeword to be the same as the codeword to be passed. The matrix used for parity regulation constraints are

$$\begin{aligned} v_0 + v_1 + v_2 + v_3 &= f_0 \\ v_4 + v_6 + v_7 + v_8 &= f_1 \\ v_0 + v_4 + v_5 + v_9 &= f_2 \\ v_1 + v_7 + v_8 + v_{10} &= f_3 \\ v_2 + v_7 + v_9 + v_{11} &= f_4 \\ v_3 + v_8 + v_{10} + v_{11} &= f_5 \end{aligned} \quad (6).$$

If the values for the variable node-set is a valid code, then each constraint equation is equal to zero. The comparisons are generalizable using equation 7 in the form

$$f_a = \bigoplus H_{ab} = 1v_b \quad (7),$$

$$a = 1\dots M, b = 1\dots N,$$

where f_a is H 's a th row, and v_b the b th column, the equations for parity checks are constructed from each row of the matrix.

The LDPC structure is made up of random bits transmitted through the AWGN channel and finally, the output is attained through LDPC decoder. In the encoder module, by multiplying the message block with the generator matrix, the information bits are coded to achieve the code words. Figure 3 shows the optimized LDPC Encoder.

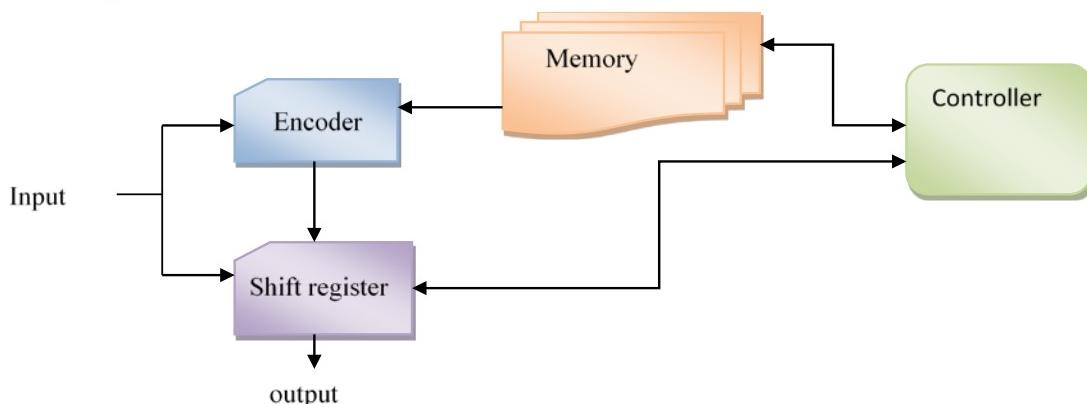


Figure 3: Optimized LDPC encoder blocks

The core of the encoder is the binary vector multiplication of the message which results in each parity bit, and there is one row of parity matrix. Memory, parity measurements, and codeword storage are used in the controllers for synchronization of message and parity check bits. In the decoder module, the parallel iterative structure is used with less hardware complexity. Figure 4 shows the optimized parallel LDPC decoder structure.

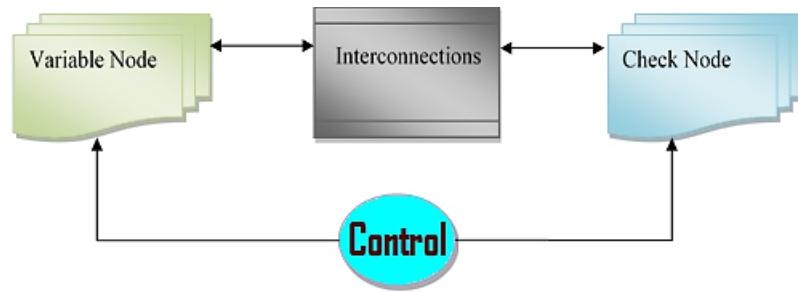


Figure 4: Optimized LDPC decoder blocks.

Optimized LDPC decoder has a separate variable and checks nodes with a highly parallel structure bypassing the message bit serial. To reduce the latency of the performance, the main consideration is the timing of the decoder by limiting the critical path through the nodes. Also, the power consumption for this design provides less dissipation.

4. Result and Discussion

The optimized LDPC encoder and decoding is designed using Xilinx 12.4 ISE tool and simulated using Verilog language. Figure 5 show the simulation result of the optimized LDPC encoder, representing the encoder waveform, the encoded output is low when the reset is low, and the message 01110101 is encoded as 010011100101. The output of the encoder will vary according to the messages.

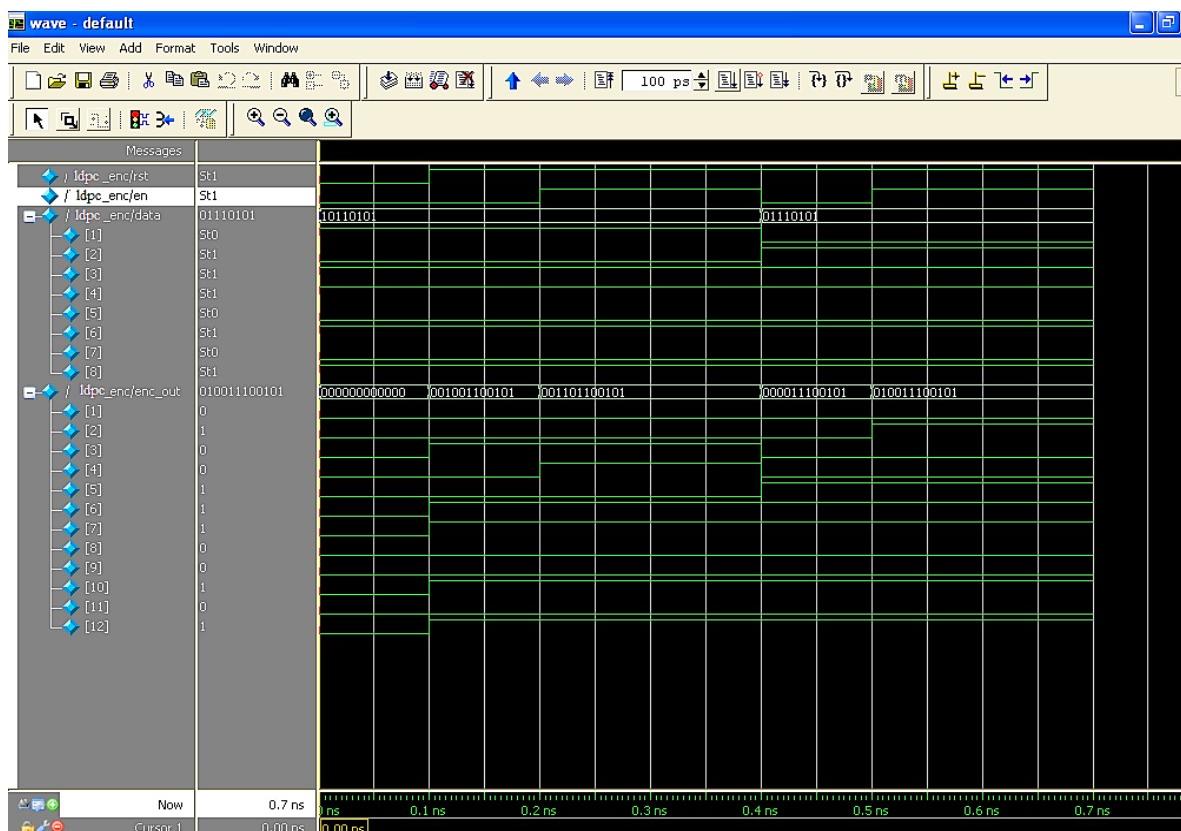


Figure 5: Simulation result of optimized LDPC encoder.

Figure 6 shows the simulation for the LDPC decoder, the decoder waveform. The decoded output is low when the reset is high, and when the resets are low, the received code is 01110101 is encoded as 010011100101. The decoded output will vary according to the proposed technique used.

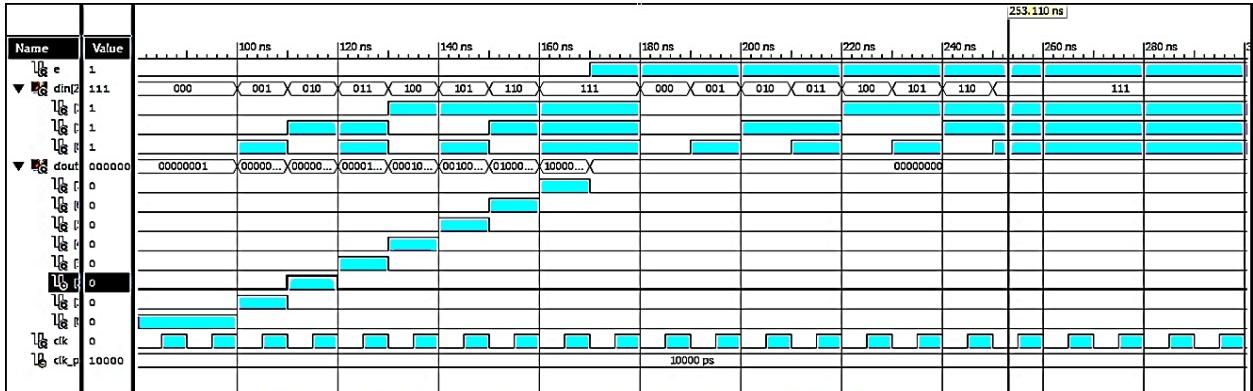


Figure 6: Simulation result of optimized LDPC decoder

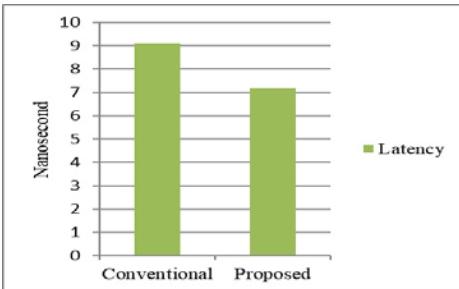


Figure 7: Performance comparison of Latency parameter.

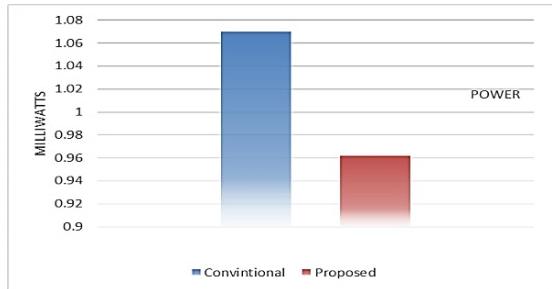


Figure 8: Performance comparison of Power consumption.

Figure 7 and 8 describes the performance of the proposed LDPC method over the conventional [1] LDPC encoder and decoder, where conventional method offers 9.1ns latency while the proposed design offers only 7.2ns. Similarly, the power consumption for the conventional design is 1.07 mw and for proposed design is 0.962 mw. This analysis proves the proposed design offers less latency and power consumption compared to the conventional design. This technique is an efficient tool for SDR communication.

5. Conclusion

The proposed system is developed and verified through obtained results using the Xilinx platform. This result is encouraging for SDR applications that require advanced-spectral characteristics with quality communication, along with improved decoding efficiency. This power-optimized algorithm is useful for the baseband encoding/ decoding processes at low cost, real-time radio receiver devices. The proposed LDPC encoder and decoder are designed and implemented in the Xilinx ISE platform. The main advantage of this iterative decoding process is low-power consumption. Generally, the LDPC is a good error-correcting code for the low-end applications in the past. This optimized parallel-structured LDPC encoder and decoder offers better performance in terms of 20.87 percent reduction in latency and 9.01 percent reduction in power consumption in comparison with the conventional method without degrading performance with less hardware complexity. This study can now be used in high-end wireless communication protocols too.

6. Availability of Data and Material

Data can be made available by contacting the corresponding author.

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Sahaya Lenin.D is a research scholar at the Department of Electronica and Communication, Hindustan Institute of Technology and Science, Chennai, India. He got his Bachelor's degree in Electronica and Communication from University of Madras, Chennai, India, a Master's degree in Communication systems from Anna University, Chennai, India. He is an Assistant Professor, the Department of Electronics and Communication Engineering, Hindustan Institute of Technology and Science, Chennai, India. His main research is the Development of a Cost-effective Radio Communication Platform using SDR Hardware Devices for Societal Need. He is also interested in DSP, Embedded Systems, Computer Networking.



Dr. Himanshu Shekhar is Professor at the ECE Department at Hindustan Institute of Technology and Science, Chennai, India. He completed his AMIE (I) in Electronics and Communication Engineering from The Institute of Engineers (India). He got an M.Tech degree in Digital Electronics from VTU, Karnataka and a Ph.D. in Software-Defined Radio from B.R.A.Bihar University, Muzaffarpur. He has also served at Vellamal Engineering College, Chennai and St Peter's Engineering College, Avadi, Chennai. His research interests include Software-Defined Radio and VLSI.



Trials and Tribulations of Common Man During Emergency in Rohinton Mistry's *A Fine Balance*

Yashika Bisht^{1*} and Shweta Saxena¹

¹ Amity Institute of English Studies and Research, Amity University, Noida, INDIA.

*Corresponding Author (Email: yashikabisht5@gmail.com).

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Abstract

This paper highlights the plight of the sufferings of the common man during the Emergency period (1975-77) which was declared by Mrs. Indira Gandhi who was the Prime Minister during that period. The paper narrates the life of two tailors, Omprakash Darji and Ishvar, during the Emergency period and how they were affected by the Emergency excesses. *A Fine Balance* is perhaps Mistry's most successful work so far. It depicts the story of four characters Dina, Ishvar, Omprakash and Maneck Kohlah. It portrays the effect of Mrs. Gandhi's Emergency on these characters. The two tailors go through extraordinarily difficult circumstances in life; from withstanding pennilessness to the unbearable torture by the government on them, leaving their lives irreparably jeopardised. The paper focuses on the tailors' as being scapegoats of Mrs. Gandhi's Family Planning and City Beautification Programmes.

Disciplinary: English Literature, India History, Social and Family Studies, Public Administration.

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1. Introduction

Rohinton Mistry is “considered to be one of the foremost authors of Indian heritage writing in English (Goodreads)”. Mistry’s figment of imagination unfolds a composing style of writing. It also conveys frightfulness of life to communicate profound kindness for the human creatures. The writings of Mistry basically concern those people who struggle to find self-worth in a family which patronises or sympathises or suppresses the individuals. Rohinton Mistry’s *A Fine Balance* “offers

an interpretation of the novel's central themes of resistance and resignation" (Almond, 2004). The Emergency Period (1975-77) brought with it a lot of controversies that are still afresh. In *A Fine Balance*, Mistry depicts how common people got badly affected due to policies of government. The then Prime Minister of India, Mrs. Indira Gandhi, who declared Emergency, introduced many policies and programmes which were being formulated for the amelioration of the common man but instead it proved to be a curse for most of the people. Schneller (2001) asserts that Mistry might not be a historian but his novel does invoke "historical thinking" which is necessary for historical writing (*ibid*).

The delineation of the characters of the two tailors in *A Fine Balance* brings to the fore the lives of the common man being overpowered by the high-class society and how being powerless and poor is a curse in such a society where they are being treated like animals. The paper will discuss the trials and tribulations of the common man and how their life was made dreary by a woman during the course of Emergency. Currently, no research has focused on the trials and tribulations of two male characters Om and Ishvar due to the oppressive policies of a woman, Mrs. Gandhi. Hence, this research paper will attempt to fill this research gap.

2. Literature Review

A Fine Balance by Mistry "is a postmodern storytelling of India's economic development during the 1975-77 Emergency (Tokaryk, 2005)." *A Fine Balance*, "initiates an investigation of globalization's rhetoric of promise and connectedness, and introduce a review of related research and other non - fictional writings (Jubas, 2005)." By way of all the drama and turmoil in the lives of the ordinary beings, the readers get to see the world and India through the eyes of the characters created by the author. Mistry's *A Fine Balance* creates "we get an intimate view, not only of their world but also of India itself in all its extraordinary variety. As the characters move from distrust to friendship and from friendship to love, *A Fine Balance* creates an enduring panorama of the human spirit in an inhuman state" (Mistry, 2001). According to Campu (2009), *A Fine Balance* marks a significant place in the world of historical novels which talks about an India that was born after independence. It throws light on the existence of the regular human beings and how their lives get affected because of the people who have the authority. It deals with the helplessness with which people lead their lives everyday and struggle to make their way out of it.

3. Trials and Tribulations of Common Man During Emergency

In the novel *A Fine Balance*, Omprakash Darji and Ishvar are the tailors who worked for a woman named Dina. Omprakash was Ishvar's nephew. They did not have their shop so they used to go to work in different places to earn their living. They had come from the village to the town to earn their bread and butter. Their only talent being stitching helped them in fetching the job of tailors. Unfortunately, both these tailors were the victims at the hands of the Emergency of which Mrs. Gandhi was the ruler. She and her government had overturned the lives of the common people. It was only three weeks into their jobs at Dina's house when the trouble started. Dina's landlord was creating problems for her and she was being served with a warning notice to stop any

“commercial activities immediately or face eviction (Mistry, 1995, p. 90).” Dina requested the tailors to keep this work a secret and that if anyone asks them of their presence in the house, they would say that they were the domestic help for her. Omprakash on being called out a servant for Dina was unhappy. He was bummed out with all the events happening around and also wished to be dead long back when his family was scorched to death.

The tailors belonged to the low caste and Narayan who was Omprakash’s father and Ishvar leant tailoring leaving behind their family’s work of being cobblers. Ishvar wanted to go to town and establish his tailoring work there. Life in the village had been very challenging and even if he would have opened up a shop there, people were poor enough to afford it and give money for their stitching. That’s why he was more bent towards the city for better opportunities and money. Narayan and Ishvar were brothers and Omprakash was Narayan’s son. Narayan did very well in his tailoring business and had also made a ‘pakka’ house. As a child, Omprakash was also being sent with Ishvar to become proficient in tailoring. Narayan and his family were set on fire in their house after he had tried to raise his voice against the injustice done during the voting. The upper caste, powerful men made lives difficult for the lower castes. Only Ishvar and Omprakash survived as they were in the city. Both had dreamed of a beautiful future in the city, of its colossal structure, of getting to see thousands of people going to work and other such imaginations. But they had a rough start on the very first day as the man who was supposed to help them in the city turned out to be helpless himself. He did not have enough food and space for his own family so he could not take an additional burden of the tailors. Nor was there any work for them available which left them going from place to place in search of it.

After months of search, the two tailors finally found jobs as tailors with a Parsi lady, Dina Dalal. They even managed to rent a small room of their own to stay. Omprakash was not much happy with the place but they had to adjust to that kind of living. The real problem had just begun with the pronouncement of Emergency rule by the Prime Minister, Mrs. Indira Gandhi. Under this Emergency regime, there were many policies that were brought into force of which the Family Planning Programme was given the utmost weightage. When Ishvar and Omprakash went to the Ration office to obtain a ration card for themselves, they were asked to present a sterilisation certificate. Ishvar lied to the officer of already having got the operation done but then he was asked to present the certificate for the same. He then gave an excuse that his certificate got destroyed due to a mishap in his shack. But this excuse was not considered as he was asked by the officer to undergo the operation again. When the officer asked Omprakash instead for the operation, Ishvar asserted that he was just a teenager and he is yet to get married and have kids. So, after all these arguments, they finally left the place without a ration card. The tailors were agitated with what all had happened at the Ration Office. But the Emergency had made the lives difficult for everyone even the government officers as all they wanted was targets. “...since the Emergency started, there's a new rule in the department- every officer has to encourage people to get sterilized. If he does not fill his quota, no promotion for him. What to do, poor fellow, he is also trapped, no” (178)?

The Emergency rules had made lives horrible for poor and powerless people while the police enjoyed it as they had complete authority to do what they wanted. If anyone was found going against the Emergency, that person was either beaten or arrested and was forced to obey what the authorities had to say.

When the Prime Minister used to come to address people in a particular area, people were being taken forcefully in buses in huge numbers and were also given promises of money and food after the PM's speech. Though it was all a lie, the people were forced to go otherwise they were being warned of getting arrested. Omprakash and Ishvar were forced to go too which made them miss their work at Dina's. The snacks were served after the speech, but the queue was very long. Hardly were people getting half a cup of tea. And when Om's and Ishvar's turn was about to come, the buses got ready to go. Obviously, the buses were the only means of transport to go back home and people left the snacks and ran towards the buses. While boarding the bus, everyone was being paid four rupees though a promise was made to pay five. But they cut one rupee for the tea, snacks, and bus fare. The tailors were very upset for a day being wasted and hence the loss of money. The bus which was supposed to drop them back to their home left them in the middle of nowhere and the rest of the journey had to be done on foot while it rained heavily. Such was the kind of injustice being done on the people and there was no one to listen to their woes.

Dina was upset with the tailors for being absent from work without any information. She warned them that if they do not come to work regularly and on time, she will hire new tailors. The tailors were helpless and they did not want to lose their jobs. So they tried and made sure that they work well and are not absent from work. The City Beautification Programme which was also one of the programmes of the Prime Minister's Emergency had left many people homeless. The people in slums were driven out of their homes by trick and later bulldozers were run over their houses. The tailors' slum was destroyed under this programme as according to the City Beautification Programme the city had to look neat, clean and attractive and the slums were just destroying that beauty. Omprakash and Ishvar were disheartened to lose their home. The bulldozers stopped for a while and gave people the opportunity to collect their personal belongings from their homes. Ishvar and Omprakash went in to collect a few leftovers in their hut like blankets and a few sheets though most of their things were also destroyed. Though most of their things were also destroyed, there were a few left things left like their quilts and linen. Next Ishvar and Omprakash went to the same man, Nawab, with whom they had stayed for sometime when they first came to the city. But unfortunately, he was arrested on false accusations. This was the kind of injustice being done on poor people by the powerful ones who had good connections with the police and politicians.

The police held the ultimate power during the Emergency period and no one could challenge them or question them even if they were doing or supporting the wrong. The two tailors had no place to go after Nawaz was arrested. They were brought on the road by Mrs. Gandhi's government and its useless policies. That night they could not find anywhere to sleep except at the railway station that was already full of homeless people. Even the following night, the tailors did not find

any place to sleep. They roamed from streets to streets in search of shelter, but could not find any. Even the hotels which they searched for to stay did not fit their budget. Then they tried to find spots in front of the shops. But most of them were already booked by the people who used to sleep there daily, so taking someone else's spot could land them in trouble. The tailors finally found a place to sleep for three rupees each night in front of a pharmacy where they had requested the night watchman to help them out. They paid the watchman three rupees a night and also "some free tailoring" (307). One can imagine the kind of life the tailors were leading due to the Emergency which had taken away their sleep and shelter, both. Though they had found temporary shelter, it did not guarantee them a good night's sleep. The nightwatchman warned them of the customers coming in the middle of the night for medications. As they started spending their nights on the streets, life became all the more difficult. They hardly got to sleep properly because there used to be customers in the middle of the night who came to take medicines hence the tailors had to get up and shift their bedding whenever a customer came. Carrying their trunk along every day to work and back was also challenging. The sleeplessness added to their work burden resulting in headaches and difficulty while stitching. Both the tailors were struggling to live properly each day. They were tired of living such a life in the city. Their lives had been miserable ever since the declaration of the Emergency by Mrs. Gandhi and her new rules. Carrying the trunk to work and back to the place where they used to sleep was becoming challenging with each passing day. The tailors' body right from their shoulders to the wrist had become so painful that they could not even sew properly at work which worried Dina (312). Seeing their condition, Dina allowed the tailors to leave the trunk at her verandah. And now the tailors did not have to carry that extra burden anymore. They changed their clothes from the trunk each evening and left after work. They had now become accustomed to the noises in the streets and could sleep better than before which resulted in the improvement of their work.

With much difficulty, the tailors' lives had become a bit stable when other big trouble landed on them. One night the policemen came with other influential people and took all the people who were sleeping on the streets. The tailors were among those arrested as according to the government, sleeping on the streets was illegal. Even after much explanation and requests, the police refused to listen to them. And when the tailors refused to get in the truck, the police constable hit Om with his stick. Such was the barbarity been done by the police during the Emergency. First, their homes were been destroyed which forced them to sleep on the streets and then they were been picked up from the streets declaring their acts as illegal. The rules formulated by the government were getting on the nerves of these poor homeless people. The tailors tried to explain that they were being picked up by mistake and that they are tailors but no one listened to them and they were forced to work as labourers there. Also, they could not inform Dina of the situation they were in and their absence from work. This made Dina angry and anxious as she had to deliver an order which was to be finished as early as possible but the absence of tailors from work made it a difficult situation for her.

Ishvar and Omprakash tried all ways out to reach the top man who could understand that they are tailors and let them be free. But no one was ready to listen to their plea. One of the men even warned them that if they give a thumbs down to the job being given to them, they would be taken away forcibly and then no one would be able to help them. Their condition was horrible and all the labourers were being mistreated there. They hardly got good food to eat and water to drink. Foul language was being used if anyone stopped working even for a minute. After spending a week of working as labourers, the tailors had started to feel as if they were in some kind of a nether world. Everyday there were scenes of their fellow labourers being knocked around or ridiculed. One day their slippers were stolen while they were asleep and they had to go barefoot for work which made their day more strenuous and by the end of the day they had difficulty walking. Ishvar's condition was falling apart so he had to see a doctor who prescribed him an ointment. After a day's rest, he had to be back for work with an inflamed and stinging foot. No mercy was shown on them. With the help of a few people, the tailors managed to get out of the irrigation project site thus thanking their stars for the luck but who knew what lay ahead.

The tailors finally reached Dina's place somehow and after seeing her, they could not stop crying. They gave an account of what terrible things had happened with them and how they had almost escaped death. They were very scared and thankful at the same time. Ishvar was highly gratified to Dinabai for giving them a roof to sleep under, as they were terror-stricken with all the Emergency things happening all around. The tailors had had a dreadful experience in the past few weeks because of Mrs. Gandhi's Emergency and they could not stop thanking Dina for being so generous to them. Dina let them sleep on the verandah till the time they found a place to stay which was not going to happen anytime soon. Their lives had been peaceful now for quite a while.

Ishvar wanted Om to get married and settle in his life but Om was not willing to. Both the tailors go back to their village to look for a bride for Om. Meanwhile, Dina also prepared for the new bride's welcome at her home. Life seemed beautiful for all of them. The tailors stayed at their uncle's, Ashraf's place in the village who had initially taught them tailoring. Their peaceful lives were turned into a nightmare when the police arrested them from the marketplace and they had no idea of the reason for their arrest. They were being put into a truck and dragged to the sterilisation camp. They both were being dragged for sterilisation. Ishvar kept requesting everyone that they did not belong to that place but everyone ignored. He requested them to spare Om as he was yet to get married and vasectomy would ruin his life and instead perform the operation only on him. But even after so many requests, the operation was being done and now the tailors were the victims of this tyranny during the Emergency. The forceful vasectomy under the government's Family planning programme ruined their lives. The doctors and the government were not interested in people's health or welfare. All they wanted was to achieve targets and conduct as many operations in a day as possible. Then the worst happened. A local leader who was taking care of these operations had a problem with the tailors so, to take his revenge, he got Om's testicles removed forever and Om was dragged to the operation room for the second time. "Om's pants were taken off for the second

time. A rag soaked in chloroform was gripped at his nose. He tore it briefly, then went limp. With a swift incision the doctor removed the testicles, sewed up the gash, and put a heavy dressing on it" (536). After the operation, when Ishvar checked on his nephew, he found his testicles missing. Highly upset with the series of events, he yelled around that Omprakash was castrated.

The two tailors after a few days of healing after the operation went to the police station to file a complaint against the doctor and the other authorities but it was very obvious that no one would even acknowledge their presence. The forced vasectomy under unhygienic circumstances led to Ishvar's grave infection. Ishvar's condition deteriorated day by day. There was swelling in his legs and unbearable pain continued. They went to see the doctor in a private hospital, away from the government people, with the condition he was suffering from and he was given a course of medicines to be followed for a couple of weeks. Although the medicines did help with the reduction in his body temperature but the condition of his legs were still the same. There was not any recovery and the reaction of the operation had reached his toes thus completely making him incapable to even stand on his legs and walk on his own. Ishvar's legs had to be amputated because of the infection which left him useless now. He could not walk anymore, all thanks to Mrs. Gandhi's Family Planning Programme and the way they were conducted. Ishvar had to be dragged in a handcart by Om and nothing could be more embarrassing for him. They decided to go back to the city because at least it was a safer place than the village where the people were mad with rage against each other. They had started feeling uncomfortable with all the tragedies which had happened in their lives and people were looking at them with disgust and even talking behind their back. So after a period of four months of hell in the village, they returned to the city. "The uncle-nephew duo returns to the city as beggars, with Om pulling Ishvar seated on a moving platform with wheels" (543). The Emergency had upturned their lives and they had become beggars now.

4. Conclusion

The two tailors have been subjected to the relentless and barbaric government policies under Mrs. Gandhi's Emergency regime. The characters of the tailors had been shown as struggling since the very beginning of their lives in the city. First was the challenge to find a shelter and then after much endeavour when can find one, it is soon demolished under the government's City Beautification Programme. This leads to the tailors sleeping on the streets. They eventually also find a job for themselves as tailors with a Parsi lady, Dina. This gives them some amount of peaceful lives but the thought of getting Omprakash married and going to their village for some time, completely capsizes their lives. The tailors are a victim of the government's Family Planning Programme thus wrecking their lives in all forms. Ishvar loses his legs and Omprakash his testicles which makes him no less than a eunuch. The misfortune strikes them forever and they are now beggars in the city from once being tailors. The two tailors fall victim to both the City Beautification Programme and the Family Planning Programme introduced by Mrs. Gandhi's Government during the Emergency. Rohinton Mistry's, thus, foregrounds the oppression of

common people by those in power in his current work and subsequently punctures the myth of welfare democratic states that work for the betterment of common citizens.

5. Availability of Data and Material

Information can be made available by contacting the corresponding author.

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Yashika Bisht is a research scholar pursuing Ph D in English at Amity Institute of English Studies and Research, Amity University, Noida, India. She pursued her Bachelor's in Arts degree from Garhwal University, Uttarakhand, and her Bachelors in Education from Amity Institute of Education, Amity University, Noida. She got a master's degree in English from Sri Dev Suman Uttarakhand University. Her area of research is based on Indian Writing in English and Feminism.



Dr. Shweta Saxena is an Assistant Professor (Grade-III) at Amity Institute of English Studies and Research, Amity University Uttar Pradesh, Noida. She was selected by Public Service Commission, Uttar Pradesh to serve as Assistant Professor in Government Degree Colleges across Uttar Pradesh. She was awarded a Ph D in English from the Department of Humanities and Social Sciences, IIT Kanpur. Her research interests span Contemporary Literary Theory, Indian Writing in English, British and American Literature and Twentieth Century Canadian Literature. She takes special interest in Postmodern Historiography which happens to be her research area in Doctoral Dissertation. She has one Book titled Historicity/Fictionality of History in Indian.



Effects of Safety Climate on Safety Performance with Moderating Roles of Safety Knowledge: Evidence from Pakistan's Textile Industry

Muhammad Hafeez ^{1,3*}, Mohsan Rashed ², Altaf Hussain ^{1,3}, Asma Javed ⁴,
Mehran Khan Tunio ^{1,3}, Muhammad Mohsin Rusool ⁵, Maeenuddin ³

¹ Department of Business Administration, Shaheed Benazir Bhutto University, Shaheed Benazirabad, PAKISTAN.

² Department of Business Administration, Lahore Leads University, Lahore, PAKISTAN.

³ Putra Business School, Universiti Putra Malaysia (UPM), MALAYSIA.

⁴ School of Economics and Management, Chang'an University, CHINA.

⁵ National Savings Office, Ministry of Finance, PAKISTAN.

*Corresponding Author (Tel +923324413597, Email mhafeez @ sbbusba.edu.pk, mhafeezsaim @ yahoo.com).

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Abstract

This study focuses on the safety climate of the textile industry and the safety performance of lower-level employees in Pakistan. Safety knowledge has been identified as a key variable to moderating the relationship between safety performance and safety climate. Safety climate aspects, influencing safety performance are investigated by distributing questionnaires on which Likert scale items are used and questionnaires are distributed to lower-level employees in the Khurriawala textile industry in Faisalabad. The descriptive and qualitative psychological approach is used. The collected data is analyzed using SPSS, tests of instrument validity; factor analysis, and inferential statistics are carried out. Simple and moderating multiple regression processes are utilized for inferring hypothesis testing. The study finds that there is a strong relationship between safety climate and safety performance. Also, the relationship between safety climate and safety performance is moderated by safety knowledge. This study contributes to decision making regarding the safety climate implementation and the role of safety knowledge with safety performance.

Disciplinary: Management Science, Occupational Health, Safety and Environment Management.

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1. Introduction

1.1 Safety Climate and Safety Culture

Empirical research on safety culture and climate has been grown impressively in the last two decades. A large portion of the research reported is directed by routines of social logic, particularly social and organizational psychology research [1]. Safety culture can be referred to as results of individual and groups values related to perception, skills, interpretation, attitude, and physiology in organizations' setting regarding health and safety management of that firm [2]

1.2 Safety Performance

Safety performance refers to notable activities/responses that persons demonstrate in all tasks to encourage the health and safety of employees, customers, the general public, and the environment [3]. Safety performance is an important part of organizational performance because its effect on financial costs relates to the health and safety of employees, industries, and governments [4]. There is no common definition of safety performance. For example, safety performance may incorporate; security association and management, safety gear and measures, mishap insights, safety preparation and assessment, accident investigation, examinations, and safety preparing rehears [5]. In this study, safety performance refers to the quality of safety-related work, and these safeties related work means efforts to achieve safety. In the study, safety-related works do not include monetary terms also safety performance is considered as a subpart of the overall performance of an organization [5].

1.3 Safety Knowledge

Safety knowledge is useful information what an individual has about safety, and skills to implement this information for his jobs to perform. In a different study, safety knowledge is considered as a mediating variable for safety climate and safety performance [6]. In this study, safety knowledge defined as “worker's comprehension of safety operating strategies and sufficient safety training and guideline” [7]. It is worth noted that industrial performance is affected by poor safety climate and low safety performance of its employees and management. The first evidence of poor safety climate is the case of Ali Enterprises, located in Plot 67, Baldia Town, and Hub Road Karachi. The major business of the firm is to exports its garments to Europe and the United States; having 12000-15000 workers. Ali Enterprises were catches fires on 11 September 2012 result in the death of more than 250 individuals and approximately 500 workers were badly injured [8].

The second evidence on 4 May 2015, another incident took place in Karachi, Site area Wali Churangi, where a garment factory catches fire result in 10 people burning including 5 women [9]. It was not simply Karachi, not Lahore and Faisalabad; even it was not just factories. There are flyovers and bridges; business and private structures as well where there is a finished absence of safety measures.

2. Research Methodology

Neal and Griffin (1997) examined the model of safety performance utilizing a documented information set, evaluated safety compliance, and safety participation. Safety knowledge was found to intercede at least some of the connections between safety climate and safety performance. Safety knowledge was not checked as a moderating variable and survey techniques were not utilized. Many studies tell about the accumulation of workers, improper state of the machine, ergonomic issue confronted by the textile laborer, dust issues, poor lighting, ventilation and unaware of personal protective equipment, not given SMS in these industries [10]. The majority of the workforce is not set up to adapt to the risks postured by manufacturing and industrial processes and procedures [11]. The country does not have the essential framework, furthermore qualified individuals for giving workplace health and safety facilities to the workers. Hence, a large number of workers will be at risk if no future attempts are made [12].

In general, safety climate is comprehended by perceptions related to the policies, methods, and practices of an association relating to workplace safety [6]. Strategies and systems for each organizational aspect are produced by the senior management and their requirement changes over them into practices. It is the inside predictable example of enacted policies showed by the management that decides safety climate. That is the reason safety climate is considered to be a construct, a result of an active process of organizational decision making, rather than an inactive study of isolated safety procedures [13].

Based on the performance review of previous studies, the model in Figure 1 shows the relationship between safety performance and safety climate. The previous section explores that safety climate is a higher-order factor and measure up by low/ second-order factors which explain the influence of safety climate on safety performance in a particular work environment. Three parts of the framework, the first are antecedents of performance, and second are the determinants of performance and the third is the component of performance as shown in Figure 1. The model describes easily if we start with components of performance.



Figure 1: Griffin and Neal Framework for the relationship between safety climate and safety performance.

Based on Borman and Motowidlo's (1993) work, Neal and Griffin (2000) define the components of performance for the workplace and show that behavior and performance are synonymous. They define observable behaviors, while performance, on the other hand, includes those actions and behaviors that are related to the organization's objective and long-term objective and that can be considered in terms of an individual's ability [14] [15] [16]. Borman and Motowidlo (1993) make a clear difference between two components of performance in the workplace i.e. task performance and contextual performance. Task performance is characterized as "The proficiency

with which work incumbents perform exercises that are formally perceived as a major aspect of their occupations... exercises that add to the association's technical core either by specifically executing a piece of its technological procedure, or indirectly by giving it materials required or services" [14]. In as opposed to task performance, contextual performance is characterized as the "exercises that fall outside the class on task performance, yet at the same time add to organizational effectiveness" [14]. There are several essential differences between these two as research also supports this distinction [17]. These differences are outlined in Table 3.

In many organizations, there is expanding acknowledgment of the need to urge staff to: receive a questioning attitude; look for approaches to enhance safety; constantly be aware of what can turn out badly; and feel personally accountable for safe operations [18] [19] recommend that safety performance ought to be measured on various levels (one of them being safety attitude), consecutively to decide the true safety altitude of an organization. They propose that measuring the safety climate, or an individual's attitude toward safety, can show changes in organizational safety behavior and thus can be useful in measuring and evaluating safety programs. There are two ways of evaluating and assessing safety performance in the organization; one is safety outcomes, which are calculated through the quantitative measure, but some studies show that these measures are not good indicator especially in case of information is gathered from the more sensitive area of the population like low-level workers. On the other hand, there are attitudinal measurements which are done through using structural interview and survey techniques, many literature works suggest that safety performance is directly related to the safety climate of an organization, which further influences the organization climate and hence overall performance of the organization. Research also agreed that safety knowledge impacts the safety performance in both dimensions of performance, it impacts safety task performance and also safety contextual performance dimension of the safety performance of an industry. However, this study explains the relationship between safety performance and safety climate in the textile industry of Pakistan.

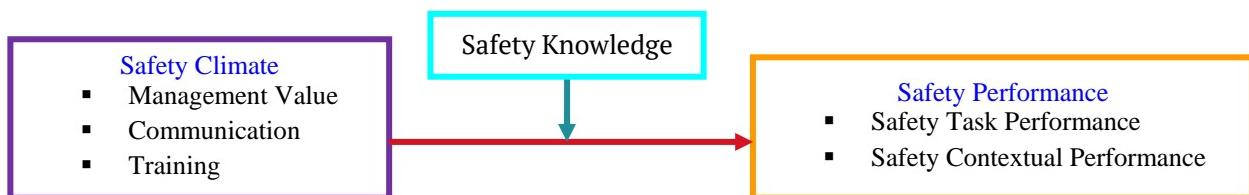


Figure 2: Conceptual framework of this research.
Source: Modified conceptual model adapted from Neal and Griffin [20]

In Figure 2, there are three variables in this study. Safety climate is the independent variable and safety performance is a dependent variable for this study and the other variable is safety knowledge which is considered as a moderating variable for this research study.

2.1 Research Methodology

The population of the research study is considered to be the lower-level workers of 30 textile/garment industries of Khurrianwala Industrial Estate Faisalabad. (M/S Arshad Corporation

(Pvt) Ltd, M/S Arzoo Textile, M/S Bismillah Textiles. M/S Interloop (Pvt) Ltd, M/S Kamal Textile Mills, M/S Ashar International (Pvt) Ltd) The population of this study is lower-level employees of the textile sector because they are facing safety-related problems in their workplaces more than any industry in the region. The target organizations have 100-15000 employees in their operational level category. The reason behind taking Faisalabad as the target area is that a major and large number of textile industry situated in this region. As per the distribution of economic activities in the country and division of labor force in a diverse setting, the number of textile firms in Faisalabad is much higher than any other geographical location [22]. At the first stage out of 30 textile units from the Khurrianwala Industrial Estate Association (KIEA) members list, a total of 5 textile mills were selected by simple random sampling technique. In the second stage, 473 workers were randomly selected from these textile mills.

Table 1: Selections of the Respondents

Name of Textile Mill	Number of Lower level Employees	Sampled Workers
A	135	49
B	1800	109
C	10707	184
D	443	75
E	290	56
Total		473

The questionnaire is prepared to keep in view the objectives of the study, furthermore, all the items of questionnaires are translated into Urdu being the native language of the country. 13 items of safety climate and 4 items safety knowledge are adopted from Neal and Griffins (2000) while the 6 items questionnaire of safety task performance, 13 items scale of safety contextual performance is adopted from study of [21] all the items are appraised on five-point Likert scale as “1” representing strongly disagree and 5 representing strongly agree. Data collection was completed within four to five weeks. At the part of the management of target population, while collecting employees number information, first of all, human resource manager, of target organizations are contacted but out of these five firms, only two organizational managers give a response and offer the detail about employees, other three organization’s detail of employees number is then collected through other means (by contacting KIEA and some personal resources). From the prospect of employees and collecting responses, in three organizations researcher has full access to go inside and take responses while in two other firms the responses are taken from the main entrance of organization at the time of leaving of employees, researchers also collect information by setting nearby dhabas (roadside restaurant)/canteen outside the target organization during their mess time.

3. Analysis and Results

The sample constituted 80% male and 20% female workers. The ratio of females in the sample was low because it is not considered virtuous for women in Pakistan to join any industry especially at a lower-level where labor-intensive work is required. In terms of three age group, the first group 18-34 years include 363 (85.8%) sample, the second age group 35-44 includes (48%) and

third 45-54 group include 12 people (2.8%). job experience is divide into five categories, the first category has 91 (21.5%) respondents in ***Below 1 year***, 269 (63.6%) respondents with less than 5 years working experience, 56 (13.2%) respondent with more than 5 years and less than 10 working experience with the organization, 6 (1.4%) respondents have less than 15 years of experience and finally 1 (0.2%) respondent have below or equal to 1 year. For educational background, different level of education have been made and was found that 109(25.8%) respondents no schooling or formal education, 37 (8.7%) respondents are primary passes, 74(17.5%) respondents are middle pass, 101 (23.9%) respondents have matriculation which is second biggest percent in these categories of education, respondents having fundamental level education are 69 (16.3%), 28 (6.6%) respondents have bachelor education, 5(1.2%) respondents have master-level education.

3.1 Validity Test/Factor Analysis

Three constructs are used in this study. Different factors are taken into consideration for these constructs and these factors are further measured through research questions. For the validity of the research questionnaire (thirty-six questions), the data is analyzed to test instrument factorial structure for all constructs (variable). A principal component is the factor extraction method which is used for this type of analysis and factors are rotated according to the varimax solution when two or more factors emerge. Second-order factor analysis of the scales is also conducted. The internal consistency test for all three types of variables is also assessed using Cronbach's Alpha. In Table 2, analysis results show that the overall model of all three construct shows sample adequacy is 0.761 by Kaiser-Meyer-Olkin (KMO) test, which indicates that data is suitable for factor analysis. The test of homogeneity of variance shows that Bartlett's Test of sphericity ($\chi^2=1746.614$, $p<.000$)

Table 2: KMO Sample Adequacy Test/ Bartlett Test for Data Distribution:

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	.761
Bartlett's Test of Sphericity Approx Chi-Square	1746.614
DF	3
Sig.	< 0.001

3.2 Reliability Test For All items

In Table 3, the overall reliability results illustrate that Cronbach's alpha is more than 0.7, showing that the instrument used in the research is reliable for this study.

Table 3: Alpha for all Items

No. of Item	Cronbach's Alpha
36	0.90

3.3 Testing of Research Hypotheses

The research instrument is followed by a five-point Likert scale questionnaire (1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree) the response is low towards strongly disagree, disagree, and neutral responses). To analyze hypotheses, SPSS®23 has been utilized. The researcher developed two major hypotheses for this study.

H#1: Safety climate is positively associated with safety performance.

A correlation and regression test was run to test hypothesis H#1. Table 4, the correlation coefficient value for all variables is more than 0.80 and P-Value is less than 0.05 that indicates that there is a strong positive and significant relationship among all variables.

Table 4: Pearson Correlations for all Variables (N = 423).

		SC	SK	SP
Safety Climate	Pearson Correlation	1		
	Sig, (2- tailed)			
Safety Knowledge	Pearson Correlation	.874**	1	
	Sig, (2- tailed)	< .001		
Safety Performance	Pearson Correlation	.929**	.926**	1
	Sig, (2- tailed)	< .001	< .001	

Table 5: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.929	.863	.856	.420

Table 5 gives the value of R and R^2 for the model. The R -value of 0.929 provides the simple correlation between safety climate and safety performance. It can be checked in Pearson correlation Table 4. The R^2 is 0.863, from which it can be inferred that the safety climate can explain 86.3 % variation in safety performance. We can also conclude that there might be some or many other factors involved in explaining safety performance, but the model under discussion has only one predictor of safety climate that explains 86 % of safety performance, the remaining 14% of the variation in safety performance can be explained by other factors involved.

Table 6: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	469.15	1	469.615	2659.643	< .001
	Residual	74.336	422			
	Total	543.951	423			

Table 6 shows the analysis results of variance (SPSS ANOVA). The F-value is 2659.643 significant at $P < .001$, so the results suggested less than 0.1% chances that an F-ratio this large would happen if the null hypothesis were true. It can be inferred that the regression model used for this hypothesis is a significantly better prediction of safety performance in using means values of safety performance. In other words, the model used produced safety performance significantly well.

Table 7: Coefficients

Model	Un- Standardized Coefficient		Standardized Coefficient	t-value	Sig.
	B	Std. Error	Beta		
1	(Constant)	0.488	0.049	1.266	.105
	Safety Climate	0.846	0.016		

Table 7 shows model parameters, it explains that if a safety climate increased by one unit it means safety performance will change by 0.846. The p-value <0.05 means significant, so we accept the hypothesis H#1 that there is an association between the safety climate and safety performance.

Safety climate generally known as shared values related to safety practices produces and thought by the upper, middle, and lower-level management of the concerned industry.

H#2: Safety knowledge moderates the relationship between safety climate and safety performance.

For the second hypothesis, a technique developed and utilized by Andrew F.Hayes called Process is used, to analyze the moderation, this regression method is a bit like the multiple regression analysis techniques. A complete discussion on the Process is already taken into a research study in the previous section; its practical implication is as follows.

Table 8: Outcome of Process Model 1.

Model 1							
X= Independent variable (IV)	Y= Dependent Variable (DV)		Moderator (M)		Sample Size		
Safety Climate	Safety Performance		Safety Knowledge		473		
Model 1							
	Coeff		SE	T-value	P-value		
Constant	2.6		.0.1	44.0	< .001		
Safety Knowlege	.432		.1983	3.10	< .001		
Safety Climate	.776		.1386	14.10	< .001		
Int 1	.381		.1378	2.88	< .001		
Int 1 Safety Climate X Safety Knowledge							
R-square increase due to interaction(s)							
	R2-chang	F		df1	df2		
Int 1	.0245	5.565		1	419		
Conditional effect of X on Y at values of the moderator(s):							
Safety Knowledge	Effect	SE	T-value	P-value	LLCI		
-0.5	.667	1	6.444	< .001	.489		
0.5	.900	.0006	19	.6164	.801		
.9114							
Model Summary							
R	R-sq	MSE	F	df1	df2		
.9291	.9171	.1402	1271.2	3	3		
					P-value		
					< .001		

In term of interpreting whatever we have moderation or not we can see in the model shown in Table 8 where under the moderator safety knowledge the interaction term (safety climate* safety knowledge) explain the moderation, we can check the moderation *p*-value it is significant i.e. 0.000, so we accept H#2 that there is moderation between the safety climate and safety performance by safety knowledge.

4. Conclusion

This study explores the safety climate of the textile industry while measuring safety performance of employees. Safety performance affects the overall performance of the firm that in turn impacts the economic performance of a country. Safety performance depends upon a perfect safety climate of a company, but a two-way check of a particular industry will provide the relationship of both the factors. Safety climate is a subpart of organizational climate and safety culture and safety climate. A complete debate on safety climate and safety culture supports the argument for using safety climate because the premise of safety climate being more obvious and unmistakable in nature, making it simpler to operate in quantifiable terms contrasted with the more dynamic safety culture. This study, in context of the textile industry of Pakistan, and the lower level workers are the population. To check the impacts of the safety performance of

employees using safety climate as an independent variable and safety performance as a dependent variable, safety knowledge is taken as a moderating role variable. This study finds that there is a positive relationship of safety climate and safety performance. This study confirms that safety knowledge moderated the relationship of safety performance and safety climate. This study helps in the implementation of new health and safety management systems. The three components are explained, strongly belongs to the employees, safety climate is for safe work. Safety knowledge is the key for safe behavior and safety performance is related to the industry's performance itself.

5. AVAILABILITY OF DATA AND MATERIAL

Data can be made available by contacting the corresponding author.

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Muhammad Hafeez is a PhD Scholar at Putra Business School, Universiti Putra Malaysia (UPM), Malaysia. Currently, He is a Lecturer at Shaheed Benazir Bhutto University Shaheed Benazirabad, Pakistan. His research interests include Organizational Sustainability, leadership, E-Recruitment, Workplace Spirituality, and Employee Performance and Retention, Health & Safety.



Mohsan Rashed is an Environment, Health and Safety (EHS) professional in a hosiery manufacturing firm. He holds a MS in management from Lahore Lead university Lahore. His interest is Workplace Safety, Health and Workers' Wellbeing Initiative Programs of Workers in Pakistan.



Altaf Hussain is a Ph.D. Scholar at Putra Business School, Universiti Putra Malaysia (UPM). Works as Lecturer at the School of Business Administration, Shaheed Benazir Bhutto University, Shaheed Benazirabad. His research area of interest is Green Consumption, Employee Retention, Health & Safety.



Asma Javed is serving in Habib Bank limited at the senior management level. She has MS Businesses Administration degree with a major in Finance. Her research interest includes Finance, Capital Markets, Earnings Management, Health & Safety and Employee Retention.



Mehran Khan Tunio is a Ph.D. Scholar at Putra Business School, Universiti Putra Malaysia (UPM). He is a Lecturer at the School of Business Administration, Shaheed Benazir Bhutto University, Shaheed Benazirabad. His research area of interest is Green Consumption, Employee Retention, and Health & Safety.



Muhammad Mohsin Rusool is serving at National Savings, Ministry of Pakistan as a Junior National Saving Officer. His Area of interest is Finance, Consumption, Employee Retention and Employee Health and Safety.



Maeenuddin is a PhD student at Putra Business School, Universiti Putra Malaysia (UPM), Malaysia. Area of interest is Finance, Consumption, Employee Retention and EHS.



Performance Analysis of Electric Vehicle Based on Various Working Scenarios

Rupali Sinha ^{1*}, and Sakshi Bangia ¹

¹ Department of Electrical Engineering, J.C. Bose University of Science and Technology YMCA, Faridabad, Haryana, 121006, INDIA.

*Corresponding Author (Email sinha.rupali1996@gmail.com).

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Abstract

With a considerable capability to decarbonize the transportation sector, electric vehicle (EV) has successfully found its place in the field of mobilization with the inclusion of battery and an electric motor in the vicinity of the conventionally utilized fuel-derived engines. These motor and other components vary the performance of the vehicle under various working scenarios. Predicated on this concept, this paper is intended to present an overview of the various components that are used inside an EV. The paper focuses on the implementation of the most simple and low run time model of EV with both DC and Brushless DC Motor by using MATLAB Simulink software. In addition to this, a mathematical analysis of the system is included to depict the prominence of vehicle dynamics in the determination of the rating of the motor. From the simulation results, it was found that Brushless DC Motors are more efficient, easily controllable, more reliable, and consume less power than that of DC motor.

Disciplinary: Electric Vehicle Engineering (EVE); Automotive Engineering.

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1. Introduction

Mobility has always been an essential part of our life and to ease up this mobilization Vehicles have always come to our rescue in various forms. But with making our life simpler it has also damaged our surroundings. According to the latest Review of World Energy 2019 presented by the British Petroleum company [1] shows that total global reserves, by fossil fuel will be exhaust between 2066-2069. In this fast depletion, Vehicle also has some of its contributions due to the presence of Internal combustion engines in vehicles that uses fossil fuels to run. This depletion has led to an increase in the cost of fuel. Also, the use of fossil fuels has several environmental impacts,

such as air pollution and global warming, as depicted by Martins et al. [2, 16]. Thus, with rising difficulties in the discovery of reservoirs of fuels under the earth, the need to reduce and replace the use of fossil fuel is increasing day-by-day. One such innovation involves the development of Power-driven vehicles or the inclusion of electric motors in place of the conventional fuel-driven vehicle.

Power-driven mobility or Electric Vehicle (EV) has reaped much more attention from both industry and academia, due to its advantages [3]: Clean (zero-emission and zero-pollution), the accommodation of avail and design (exhibits drive efficiency, distance covered and time to charge), cost- efficacious, good connectivity, etc. The inclusion of electric motors can be easily done in any type of vehicle, i.e., car, scooter, auto-rickshaw, etc. Moreover, EV includes are not just limited to roads. They have also become a prominent part of railways, sea-ways, and even in the sky as electric aircraft and satellites.

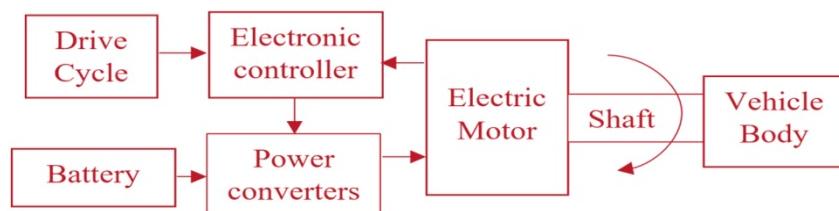


Figure 1 General Block Diagram for EV

Figure 1 shows the general block diagram of EV having different controllers, an electric motor, battery, power converters, and vehicle body [4]. The Integration of all these units is necessary to run the vehicle. In EV, batteries are utilized as the main energy source of the vehicle and supply the requisite amplitude of energy to the motor, which as a result runs the vehicle. Batteries are connected to the motor through various Power converters and controllers that help in controlling and optimizing the flow of power between the two. Lastly, the mechanical output from the motor is supplied to the wheel through the driving shaft present in the motor that helps the wheel to rotate. As presented by Bhatta et al., 2019 and Anurag and Date, 2015, to date EV's are making use of the electric motors, e.g., DC Motor, Brushless DC (BLDC) Motor or Permanent magnet Brushless DC (PMBLDC) motor, Induction (AC) Motor, Permanent magnet Synchronous motor or PMSM and Switched Reluctance motor (SRM) [5, 6]. Each of these motors has different performance parameters under different conditions. Based on this concept, the performance of DC and BLDC motors in an EV is analyzed and presented in this paper.

To date, EV's are making use of various electric motors. Each of these motors has a different working principle, constructions, and features when integrated with EV. Based on their pros and cons, they have found their application in EV as per the load requirements. This paper has explored the idea of the Integration of two different motors in vehicles i.e., DC Motor and BLDC Motor, and their performance is studied in detail.

Two key elements of power-driven mobility are Battery and the Electric motor. Now there are various motors used in EV. Predicated on this concept, analysis of the performance of DC motor and BLDC motor inside the EV is done in this paper. Also, when the vehicle is under operation

battery continuously discharges. Thus, the study of the state of charge of battery before and after operation of the vehicle is also done. For proper analysis, two different drive cycles (steady-state cycle and transient cycle) are taken under consideration. A feed-forward loop is also added to analyze the impact of Regenerative Braking on the motors are also taken under analysis.

For this paper, a simulated model of EV was developed using MATLAB Simulink R2018a (2018 Edition) software. EV's with two different motors, that is, DC and BLDC motor, at two different drive cycles, are taken into consideration and are studied in detail.

2. LITERATURE REVIEW

A profound study of past articles and papers have been done for the prosperous development of this paper. The vision of the research is supported by a literature-driven methodology carried out to unravel the relevant technologies and methodologies.

Table 1: Literature survey.

Author	Objective	Key Findings
Xin et al. [9]	SOC determination	The authors compared the Extended Kalman Filter algorithm with Kalman Filter and Coulomb counting.
Bhatta P. N. et al. [5]	Analysis of efficiency, power density, and size of EV	For all the characteristics PMBLDC motor shows the best results.
Warake et al.[8]	Regenerative braking in EV	The proposed analysis is based on the experimental set-up and simulated model developed using MATLAB software.
Kusum and Parveer [15]	Powertrain components	The proposed method includes designing and simulation of EV using MATLAB software.
Tiwari and Jaga [4]	Component study of EV	Comparative study of various components of EV is done.
Abulifa et al. [10]	SOC determination	The paper presents the simulated model for EV developed using MATLAB Simulink Software.
Porselvi et al. [12]	Motor rating analysis	The power rating of EV is found referring to the vehicle dynamics and speed of the motor is found using ANSYS Maxwell Software.
Berjoza and Jurgena [14]	Vehicle dynamics analysis	The paper presents a methodology to determine vehicle dynamics based on the weight of the battery.
Lulhe and Date [13]	Speed controller and PWM inverter designing	The paper includes the modeling and simulation of EV using induction motor in MATLAB Simulink software.
Maini et al. [3]	EV Characteristics	The paper outlines the main concept behind the growth of EVs.

Based on the literature survey summarized in Table 1, an appropriate design mechanism of Electric Vehicle and Integration of Various components that are used in an EV structure was examined in brief. It was found that the simulation model previously [10], [13] and [15] in MATLAB uses Simulink block-sets in which the resulting diagram obtained is equivalent to its mathematical model. For a change, in this paper, the simulated model was prepared using Simscape Block-sets that has a physical modelling approach and is analogous to connecting real components that helps in understanding the physical connections between two components and gives an appropriate picture of the physical system. An appropriate analogy of vehicle dimension was obtained and is depicted in this paper, from [12, 13]. Also, by considering the analysis [14], the weight and the capacity of the battery is considered. Based on Xin et al. [9], the SOC estimation is done using the Coulomb counting method. To extend the analysis [8], this paper includes an analysis of the impact of regenerative braking using various drive cycles.

3. Materials and Methodology

3.1 Vehicle Resistance

Forward movement of the vehicle is opposed by the various resistive forces [7]. These resistive forces include,

3.1.1 Tire Rolling Resistance

The force exerted against the rotational movement of the tire on the road is known as the tire rolling force. It can be expressed as,

$$F_r = m_v g C_R \cos \alpha \quad (1)$$

Here, m_v is the mass of the vehicle, g is the gravitational acceleration, C_R is the rolling resistance coefficient and α is the road/ grade angle.

3.1.2 Aerodynamic Drag

Atmospheric air around is always pushed by a running vehicle but this air does not move out instantly and thus produces a resistive force known as aerodynamic drag/ resistance. This force can be expressed as,

$$F_a = 0.5 \rho A_f C_D (V_v + V_0)^2 \quad (2)$$

Symbol V_v is the vehicle speed, C_D is the aerodynamic drag coefficient, A_f is vehicle frontal area, V_0 is the component of wind speed on the vehicle's moving direction and ρ is the air density.

3.1.3 Grading Resistance

A force is produced due to the mass/weight of the vehicle while moving on a sloping road. This force experienced by the vehicle on the sloping road is known as Grading Resistance. Mathematically, the Grading force can be expressed as

$$F_g = m_v g \sin \alpha \quad (3).$$

3.2 Regenerative Braking

Kinetic energy lost 10-15% during braking or deacceleration can be regained by the electric motor inside [8]. The energy so regained is converted to electrical energy and is fed back into the battery source. This could thus lead to an increase in efficiency and charge of the battery. This process of regaining the energy lost during acceleration comes under the regenerative energy recapture system.

3.3 State of Charge Estimation

Batteries have an inhibited amplitude of energy and discharge continuously when the vehicle is under operation. In this paper, we have used the Coulomb counting method for SOC estimation [9]. It is defined as the ratio between the residual charge available $Q(t)$ and the nominal capacity $Q_{nominal}$ in SOC [10].

$$SOC = \frac{Q(t)}{Q_{nominal}} \quad (4)$$

3.4 Drive Cycle

The driving cycles are basically the speed Vs time graphs having a fixed schedule, that are used to estimate the fuel or power consumption of the vehicle [11]. Based on the variation of speed with time the vehicle can be classified as steady-state drive cycle and transient drive cycles. In the steady-state drive cycle, vehicle speed remains almost constant with time while in the transient drive cycle, speed is more or less continuously varying with time.

This study was conducted for both types of cycles. For transient cycle, standard drive cycles, Artemis Motorway 130 pre-post Cycle was considered. For the steady-state cycle, a reference drive cycle was developed using signal builder block in MATLAB Simulink Software which is shown in Figure 2.

Maximum run Time: 1000 sec,

Maximum Speed: 30 m/sec,

Total distance covered: 29.97 Km.

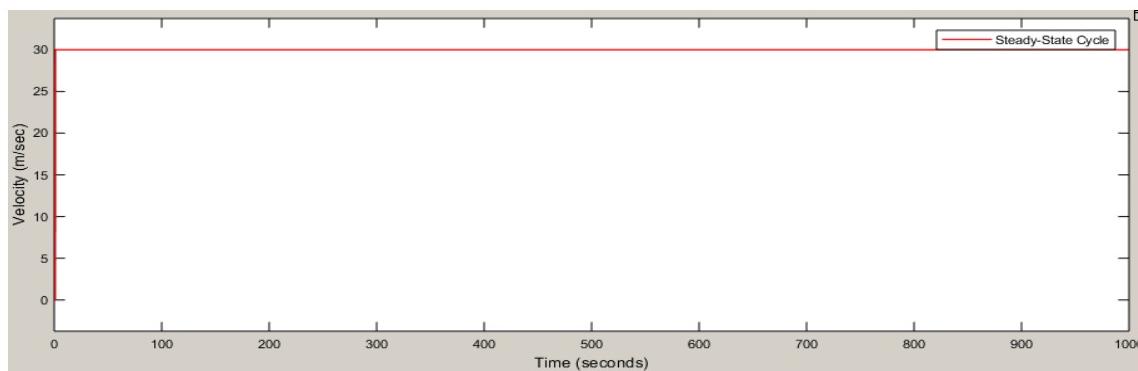


Figure 2: Steady-state drive cycle.

4. Mathematical Analysis

The calculation of the input values that are assigned to each component Integrated to develop the Simulink model of EV is discussed in [12-15] and are summarized in Table 2.

Assume, Total no. of passengers = 4, and each passenger's weight = 65 Kg. Thus, Total Passenger Weight = $4 * 65 = 260$ kg. Now, assume the Weight of the battery = 290 Kg, Hull weight = 400 Kg, and Motor weight = 50 kg. Then, the mass of the vehicle m_v , can be defined as the sum of total passenger weight, weight of the battery, hull weight, and motor weight, i.e.,

$$\begin{aligned} m_v &= \text{total passenger weight} + \text{weight of battery} + \text{hull weight} + \text{motor weight} \\ &= 260 + 290 + 400 + 50 = 1000 \text{ kg} \end{aligned} \quad (5)$$

Now, take grade angle $\alpha = 0^\circ$, rolling resistance coefficient $c_r = 0.015$, gravitational acceleration $g = 9.81 \text{ m/s}^2$, air density $\rho = 1.225 \text{ kg/m}^3$, vehicle speed $V_v = 42 \text{ m/sec} = 151.2 \text{ km/hr}$, component of wind speed $V_0 = 3 \text{ m/sec}$, and $A_f C_D$ (for executive car) = 0.55 m^2 .

Then, from Equations (1), (2), and (3), the values of Rolling resistance, Aerodynamic drag and Grading resistance can be found as

$$F_r = m_v g C_R \cos \alpha = 1000 \times 9.81 \times 0.015 \times \cos 0^0 = 147.15 \text{ N} \quad (6),$$

$$F_a = 0.5 \rho A_f C_D (V_v + V_0)^2 = 0.5 \times 1.225 \times 0.55 \times (42 + 3)^2 = 682.171 \text{ N} \quad (7),$$

$$F_g = m_v g \sin \alpha = 0$$

$$\therefore \text{as } \alpha = 0, \text{ then } \sin \alpha = 0 \quad (8).$$

So, the total resistive force is again the sum of rolling resistance, aerodynamic drag and grading resistance i.e.,

$$F_{total\ resistive} = F_r + F_a + F_g = 147.15 + 682.171 + 0829.321 \text{ N} \quad (9).$$

And Total tractive power is

$$P_{total\ tractive} = \frac{F_{total\ resistive} \times V_v (\text{in km/hr})}{3600} = \frac{829.321 \times 151.2}{3600} = 34.831 \text{ KW} \quad (10).$$

Total mechanical power P_{mech} or rated power output is defined as the ratio of Total tractive power divided by transmission efficiency (η) and can be expressed as

$$P_{mech} = \frac{P_{total\ tractive}}{\eta} = \frac{34.831}{0.86} = 40.5 \text{ KW} \quad (11).$$

Further assuming gear ratio = 3.7 and the radius of the wheel $r_w = 0.3 \text{ m}$. Then, Vehicle speed in rpm (Revolution per minute) can be defined as

$$V (\text{rpm}) = \frac{V_v (\text{in m/sec}) \times 60}{2\pi r_w} = \frac{42 \times 60}{2\pi \times 0.3} = 1336.364 \text{ rpm} \quad (12).$$

The Rated Speed of the Motor is

$$S_M = V (\text{rpm}) \times \text{Gear Ratio} = 1336.364 \times 3.7 = 4944.5 \approx 5000 \text{ rpm} \quad (13),$$

and

$$\text{Maximum Torque} = \frac{P_{mech} \times 60}{2\pi \times S_M} = \frac{40.5 \times 60}{2\pi \times 5000} = 77.3 \approx 80 \text{ N-m} \quad (14).$$

Table 2: Input Parameters

MOTOR SPECIFICATIONS (DC MOTOR)		
1	Rated power output	40.5 KW
2	Rated input voltage	300 V
3	Rated No load speed	8000 rpm
4	Rated speed	5000 rpm
MOTOR SPECIFICATIONS (BLDC MOTOR)		
1	Rated power output	40.5 KW
2	Maximum Torque	80 N-m
3	Motor Efficiency	96%
BATTERY		
1	Battery rating (in Ah)	80 Ah
2	Supply Voltage	300 V
VEHICLE DYNAMICS		
1	Gear Ratio	3.7
2	Wheel radius	30 cm
3	Transmission efficiency	86 %
4	Mass of the Vehicle	1000 Kg
5	Inclination	0°

The discussed mathematical analysis defines the dependence of the rating of the motor to the vehicle dynamics. Thus, this can be understood that Vehicle dynamics are a prominent part in the determination of the rating of the motor.

5. EXPERIMENTAL ANALYSIS

This section includes the simulated model (experimental analysis) of EV with both DC Motor and BLDC Motor and also includes various subsystems that are developed using MATLAB Simulink (Sim-scape) software tool.

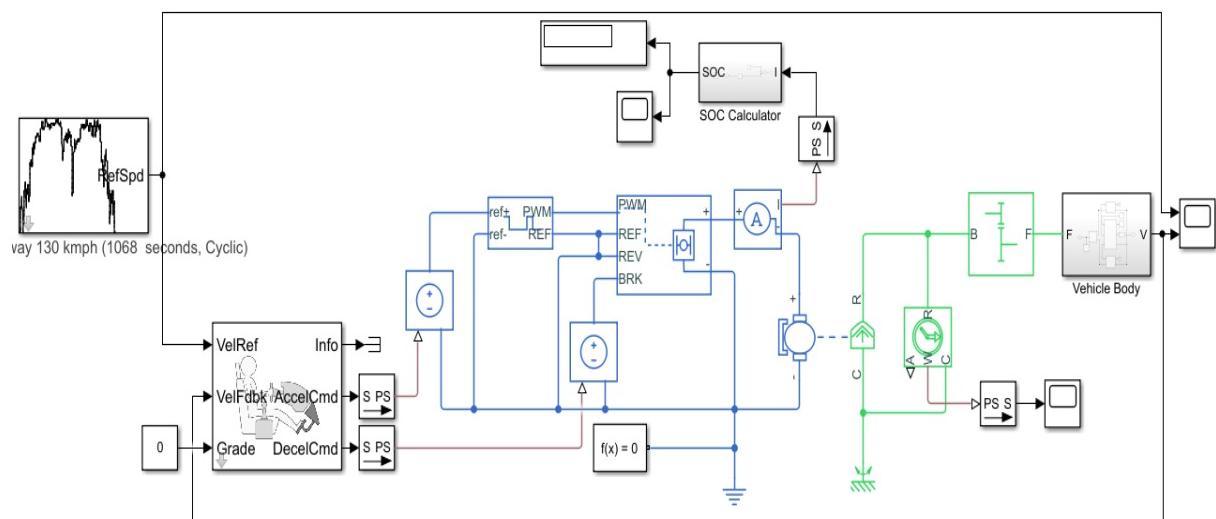


Figure 3: Simulink Model for DC Motor

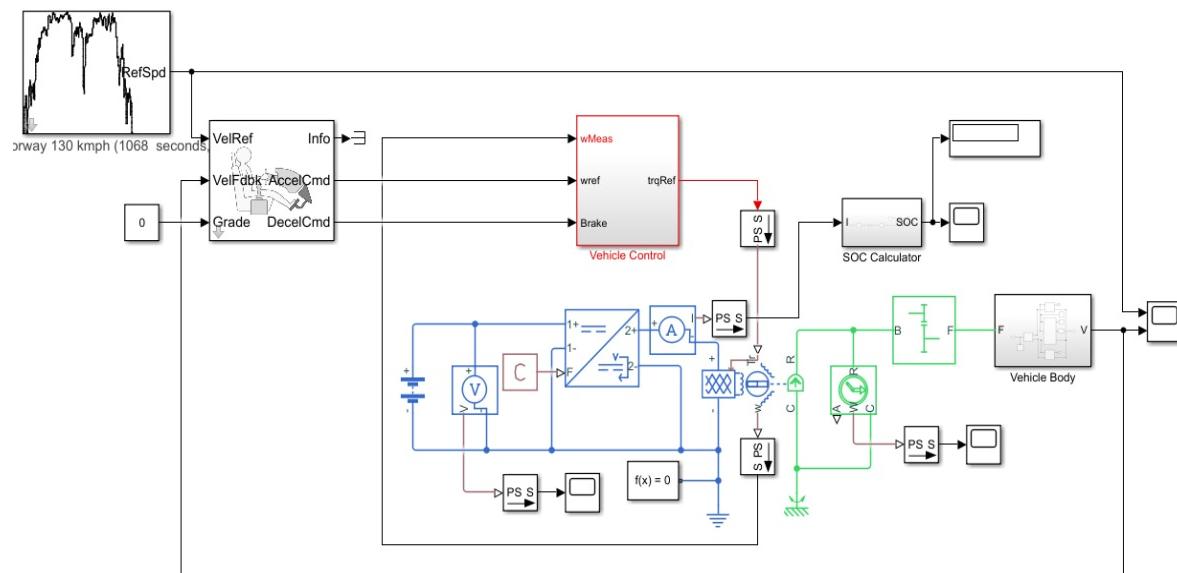


Figure 4: Simulink Model for Brushless DC Motor

In the Simulink model shown in Figure 3, for DC motor the speed of the motor is controlled by connecting a Speed controller or PI Controller through a PWM voltage controller and H-Bridge. Both these blocks are available in the Simulink Library. The H- Bridge block in MATLAB is designed such that, by default, it provides regenerative braking to the system. For the BLDC motor shown in Figure 4, the speed of the motor is controlled through an electronic controller and power input to the motor is supplied through a dc/dc converter which allows bi-directional flow of current. The simulated model for the electronic controller/ Vehicle speed controller shown in Figure 5 consists

of speed controller, braking system and a feed-forward network to provide regenerative braking to the system.

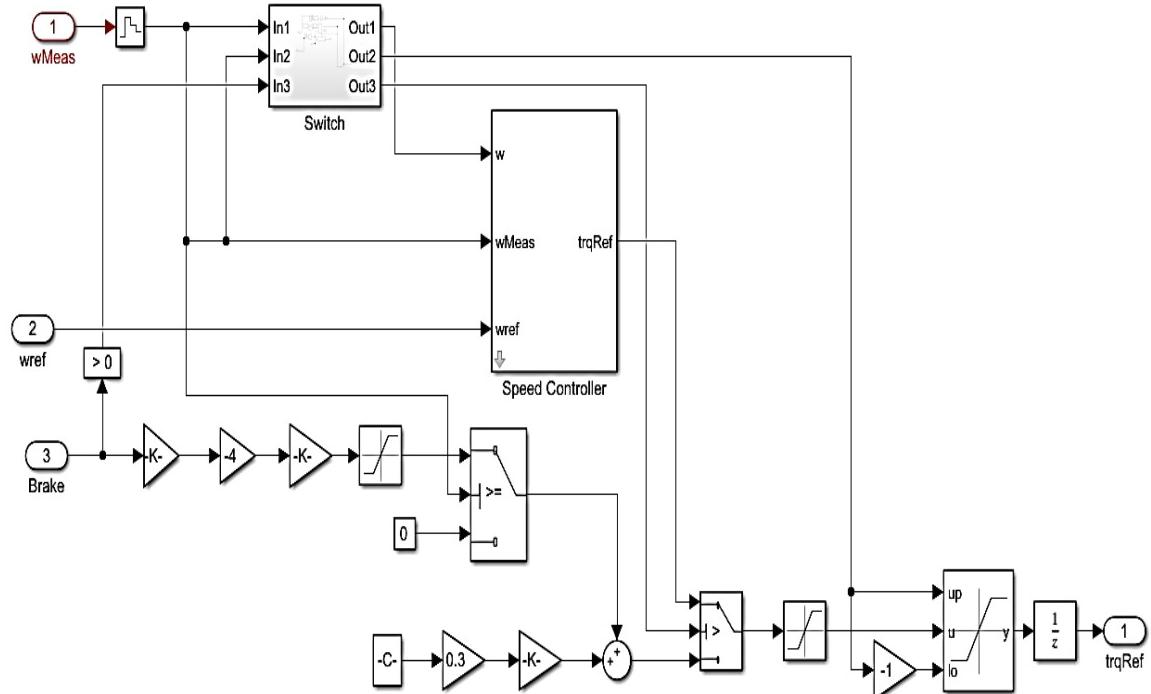


Figure 5: Simulink Model for Vehicle speed controller.

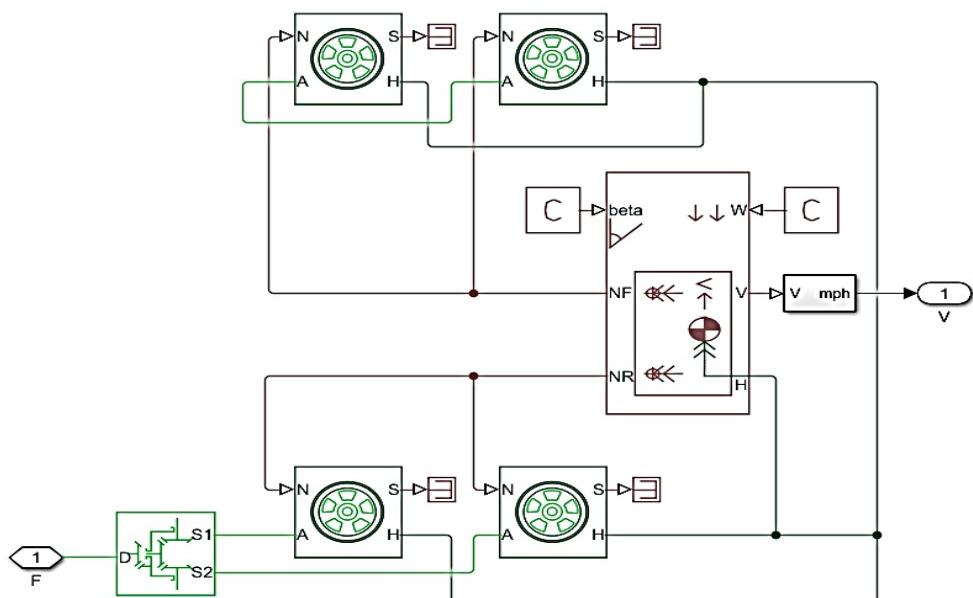


Figure 6: Simulink Model for Vehicle Body.

Vehicle parameters such as Vehicle resistance, the mass of the vehicle, the radius of the wheel, gear ratio, etc. are assigned at the Simulink model shown in fig 6. This Simulink model consists of wheels that are connected to the motor through the gear and differential.

6. Observations

6.1 Drive Cycle analysis

This includes the curve for Drive cycle input for both steady-state and transient cycle input (Artemis cycle) Vs Vehicle speed for both DC and BLDC motor.

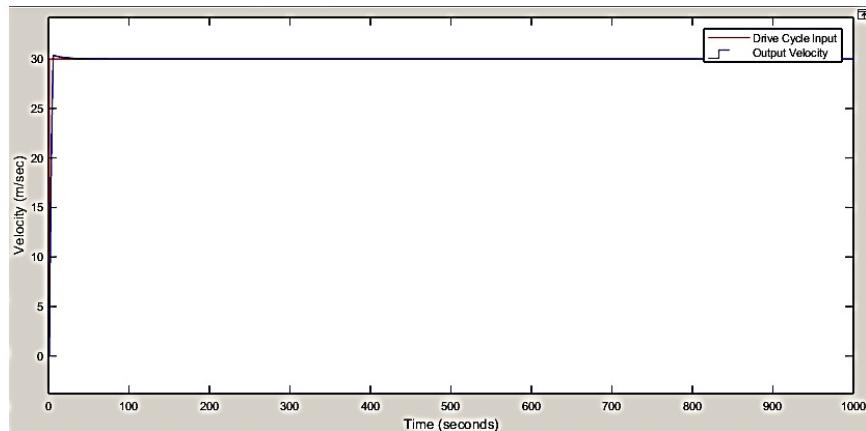


Figure 7 DC motor Input Vs Output Velocity Graph for Steady – State Drive Cycle

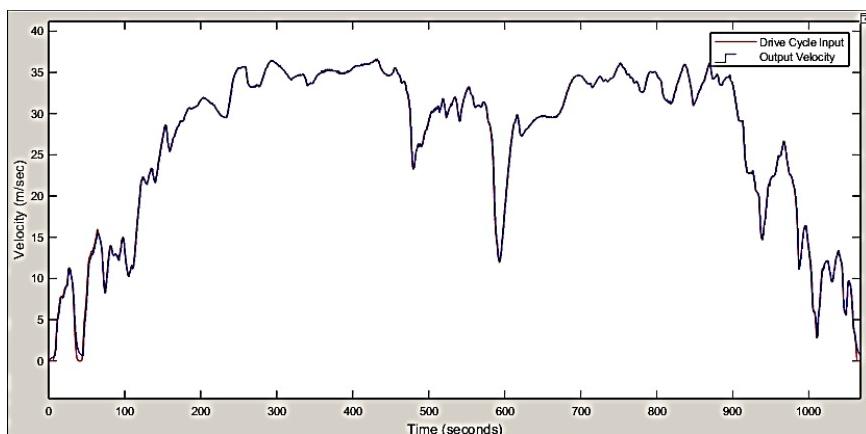


Figure 8 DC motor Input Vs Output Velocity Graph for Artemis Motorway Cycle

According to the simulation curves for transient and steady-state drive cycles, i.e. Figures 7 and 8 obtained for DC motor, it is found that the drive cycle speed and vehicle speed are almost overlapping each other. Hence, it is understood that the vehicle speed and the drive cycle speed for DC motors were almost the same. At some points in drive cycle curves, there is a slight variation found between the drive cycle and vehicle speed. This is due to the motor/vehicle inertia.

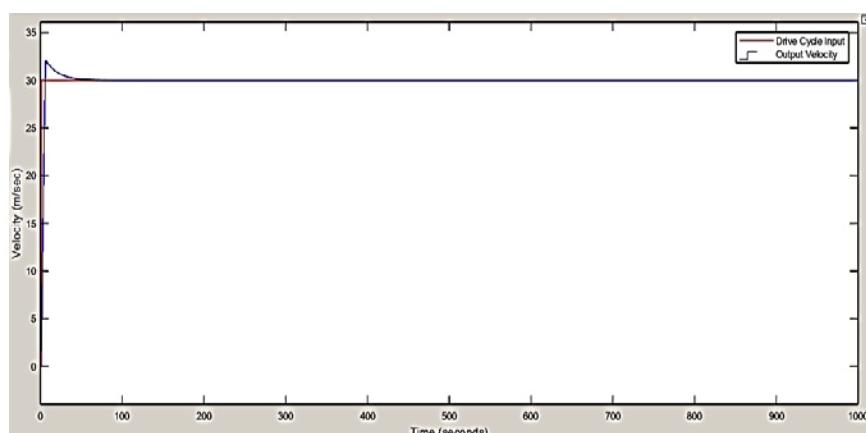


Figure 9 BLDC motor Input Vs Output Velocity Graph for Steady-State Drive Cycle.

According to the simulation curves for transient and steady-state drive cycles, i.e. Figures 9 and 10, obtained for BLDC motor, it is found that the drive cycle speed and vehicle speed are almost overlapping each other. Hence, it is understood that the vehicle speed and the drive cycle speed for

BLDC were almost the same. At some points in drive cycle curves, there is a slight variation found between the drive cycle and vehicle speed. This is due to the motor/vehicle inertia.

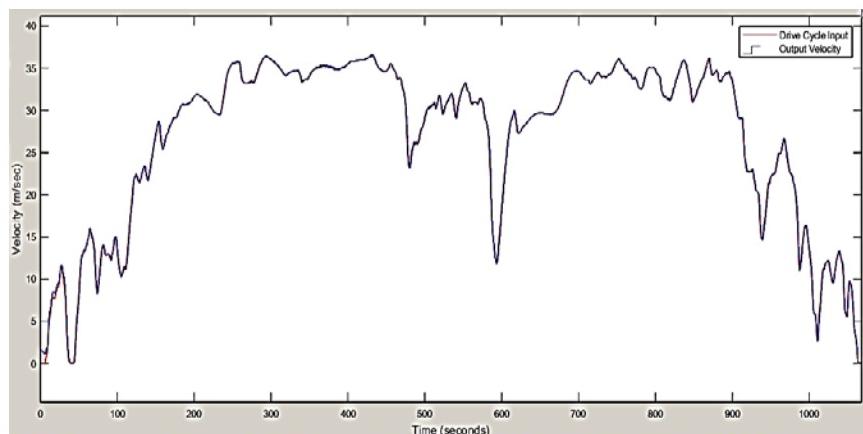


Figure 10: BLDC motor Input Vs Output Velocity Graph for Artemis Motorway 130 cycles.

6.2 State of Charge

In this section comparison of SOC of DC motor and BLDC motor is done for the same type of drive cycle inputs.

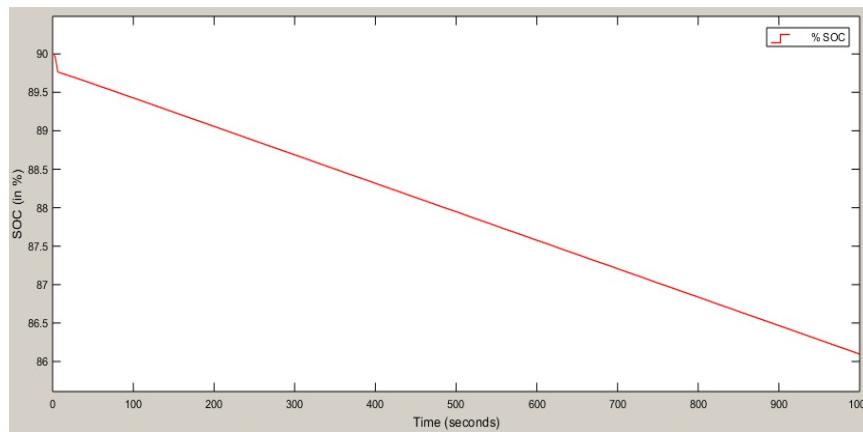


Figure 11 SOC of Steady-state cycle for DC Motor.

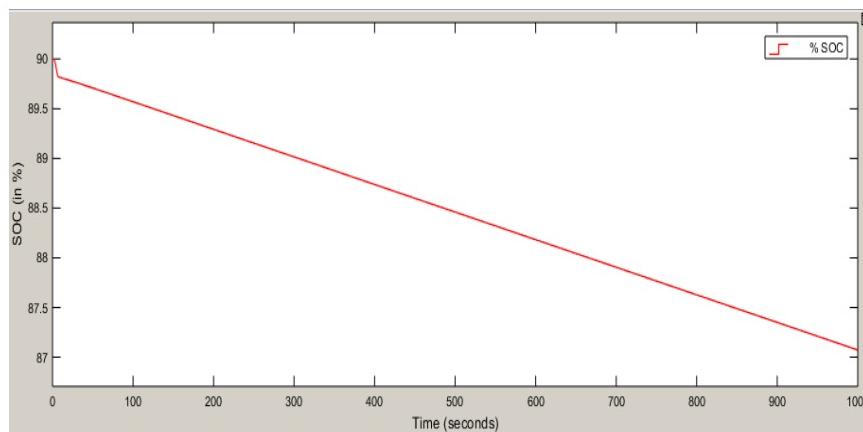


Figure 12 SOC of Steady-state cycle for BLDC Motor

Figures 11 and 12 include the curves of Steady-state cycles for DC and BLDC motor respectively. It is seen in the curves that the rate of discharge is almost the same for both DC and BLDC motor, for a similar drive cycle. At the time from 0 to 1 sec, the vehicle speed is increasing so power consumption is slow but at a time greater than 1 sec as the vehicle gains a constant speed of

30 m/s the power consumed by the vehicle is higher than the before, and thus, the rate of discharge of vehicle battery also increases.

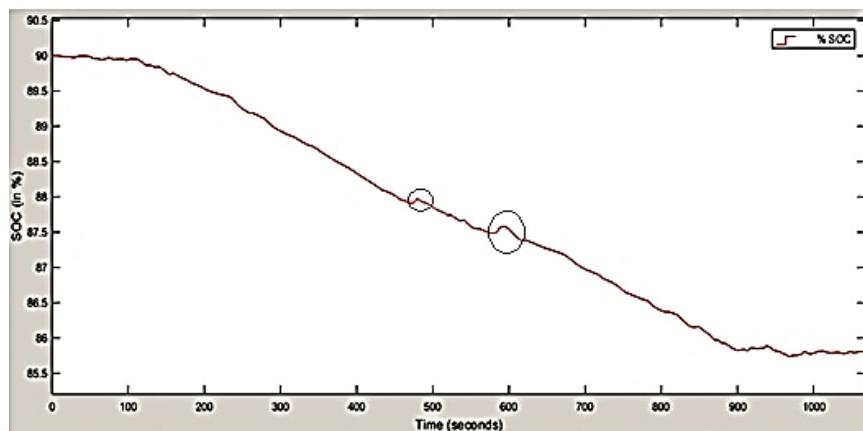


Figure 13 SOC of Artemis motorway cycle for DC motor.

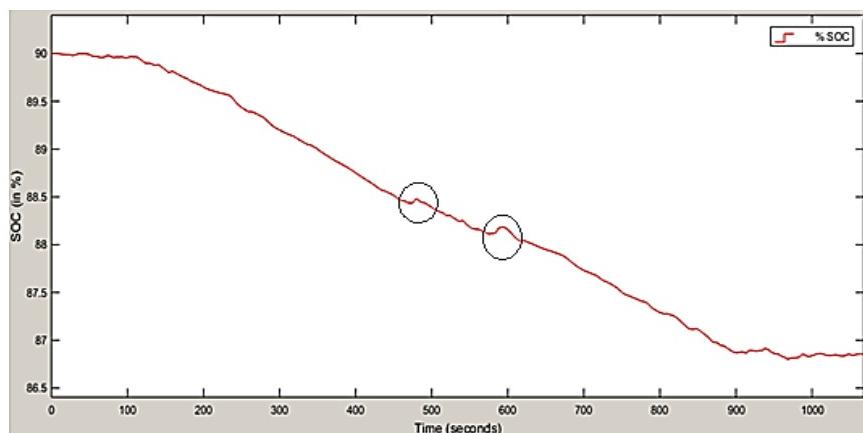


Figure 14 SOC of Artemis motorway cycle for BLDC motor.

Figures 13 and 14 include the curves of Artemis Motorway cycles for DC and BLDC motor respectively. It is seen in the above curves that the rate of discharge is almost the same for both DC and BLDC motor, for a similar drive cycle. From the SOC curve for Artemis Motorway cycle, it is also observed that at some point encircled in Figures 13 and 14 where the vehicle deaccelerates, there is a slight increase in SOC. This is due to the effect of regenerative braking applied.

6.3 Power Curve

When the electrical power is fed to the motor, then this electrical input is converted to the mechanical power that helps in rotating the shaft. In between this conversion from electrical input to mechanical output some energy is lost due to various losses inside the motor, such as, iron loss, copper loss, Stray loss, brush friction loss, etc. due to which there is some amount of variation in electrical input and mechanical output. This variation curves between the Electrical input and mechanical output of the EV for both DC and BLDC motor when derived at different drive cycle is studied below and the result obtained is discussed after that thereon.

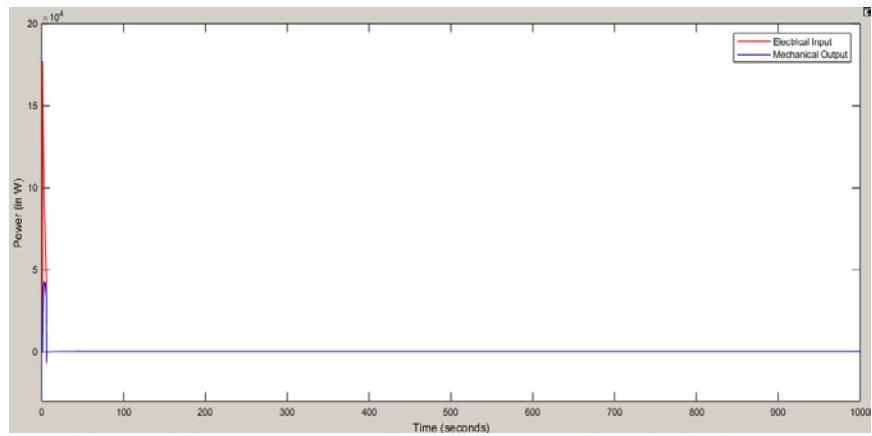


Figure 15 Power curve of steady-state drive for DC motor.

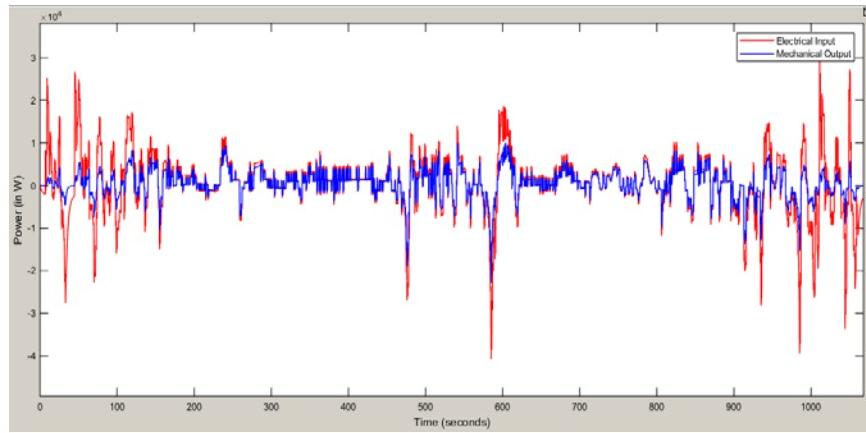


Figure 16 Power curve of Artemis motorway cycle for DC motor.

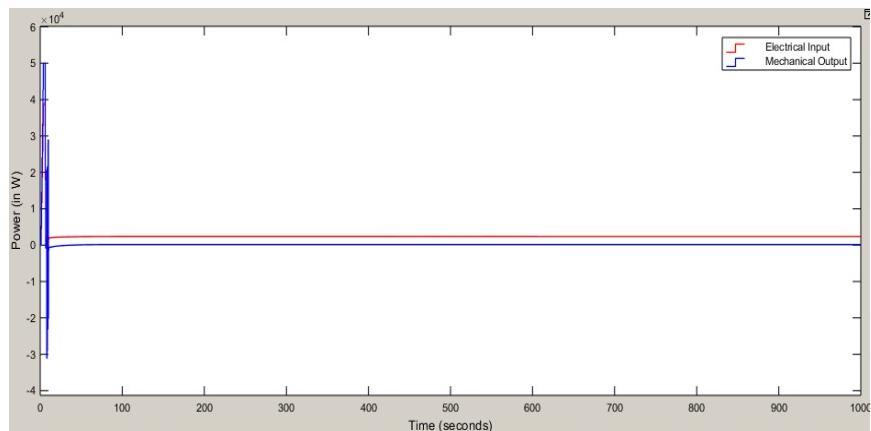


Figure 17 Power curve of the steady-state drive for BLDC Motor

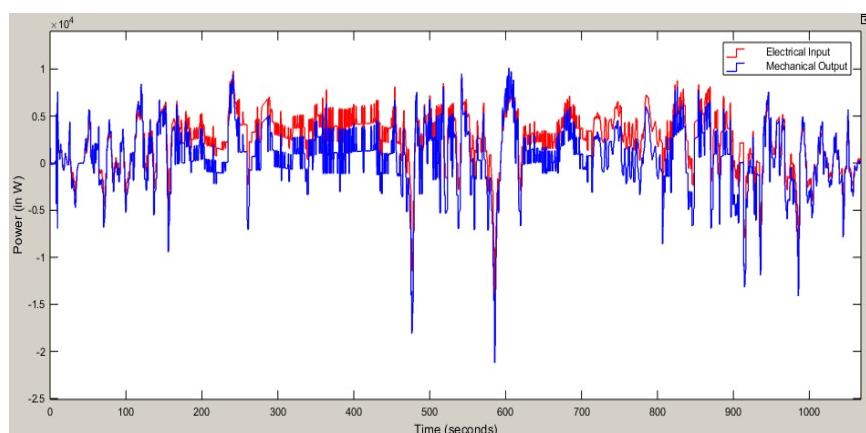


Figure 18 Power curve of Artemis motorway cycle for BLDC motor.

It is found from the curves of electrical input Vs mechanical output power (i.e. from Figures 15 to 18) that, in BLDC motor, the variation is less between the two curves compared to that of DC motor. This means that losses are less in the BLDC motor compared to that of the DC motor. Hence, this justifies the high efficiency of the BLDC motor compared to that of the DC motor.

Based on the Modelling and the simulation of the Electric vehicle done using MATLAB Simulink Software, the performance and impact of various parameters on EV are verified. The outcomes of the parameters so assessed through the simulation are discussed in Table 3.

Table 3: Observation table for drive cycle

Parameter	DC MOTOR		BLDC MOTOR	
	Artemis Motorway 130 Cycle	Steady-State Cycle	Artemis Motorway 130 Cycle	Steady-State Cycle
Time (sec)	1068	1000	1068	1000
Maximum speed (m/s)	40.44	40.44	41.78	41.78
Maximum speed (rpm)	7880	7880	8140	8140
Standard distance covered (km)	28.77	29.97	28.77	29.97
Observed distance covered (km)	28.74	29.92	28.76	29.94
Initial State of Charge (%)	90	90	90	90
State of Charge (%)	85.81	86.1	86.86	87.07

SOC as mention in observation Table 3 shows that the amount of charge lost with DC motor is greater than that of BLDC motor, or, for the steady-state cycle, SOC of DC motor is 86.1% whereas for Brushless DC motor it is 87.07% which is lesser than DC motor. Similarly, in Artemis Motorway cycle for DC motor SOC is 85.81 % and for BLDC motor is 86.86%. Thus, the power consumed by the BLDC motor is less than in comparison to that of the DC motor.

Table 4: Vehicle mass and state of charge

Vehicle Mass (Kg)	State of Charge (in %)	
	For DC Motor (Artemis Motorway 130 Cycle)	For BLDC Motor (Artemis Motorway 130 Cycle)
850	86.92	88.01
1000	85.81	86.86
1100	84.79	85.89

From the observation Table 4, it is found that as the mass of the vehicle is increased for both DC and BLDC motor the amount of charge present in the battery reduces. This means that for propulsion of heavier vehicle more power is consumed compared to that of the power consumed for a light vehicle.

7. Conclusion

This paper presents an overview of the various components that are used in EV structures and how they are integrated together inside the vehicle. The shaped apparition is converted into a realistic baseline scenario by focussing on the Simulation and modeling of Electric vehicles with DC and BLDC motor for various drive cycles using MATLAB Simulink R2018a software. The vision of the research is supported by a literature-driven methodology carried out to determine the relevant technologies. The simulated model of the electric vehicle was successfully developed and is

included in this paper. Comparing the results obtained for both the motor, it was found that BLDC Motor is more efficient, easily controllable, more reliable, and consumes less power than that of DC motor. For both the motor the vehicle speed and drive cycle speed was found to be almost the same. Also, the inclusion of regenerative braking shows that some amount of energy lost during deacceleration can be regained and fed-back to the battery. Thus, this concludes that with improvement in the regeneration braking system, the efficiency can be improved to a lot more level. The impact of the mass of vehicles on power consumption is also observed which shows that power consumption of the vehicles increases with an increase in the mass of the vehicle. Also, through the mathematical analysis of the system, it was found that the Vehicle dynamics are a prominent part in the determination of the rating of the motor. The presented work confirms that in near future with development in some performance parameters, Electric vehicles could govern the mobility market.

8. Availability of Data and Material

Data can be made available by contacting the corresponding author.

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Rupali Sinha earned a B. Tech. in Electrical Engineering from Guru Gobind Singh Indraprastha University, Delhi, India in 2018. She got her M. Tech. in Electrical Engineering (Power Systems) from J.C Bose University of Science and Technology YMCA, Faridabad, Haryana, India. Her area of research interest is Power Quality, Power Stability and Electric Traction Systems..



Dr. Sakshi Bangia is an Assistant Professor at Electrical Engineering Department, J.C. Bose University of Science and Technology, YMCA Faridabad, India. She holds a B. E. in Instrumentation and Control Engineering from Maharishi Dayanand University, India and an M. Tech. in Power Systems and Drives from Maharishi Dayanand University, India. She got her Ph. D. in Power Quality from Maharishi Dayanand University. Her area of research interest is Power Quality and Controls Systems. She is a lifetime member of Institute of Engineers, India, Indian Society for Technical Education (ISTE) and Institute of Engineering and Technology (IET).



Trip Types of Community Malls

Benchaya Pimcham¹, Winai Raksuntorn^{1*}, Boonsap Witchayangkoon¹,
Nareenart Raksuntorn², and Songrit Chayanan³

¹ Department of Civil Engineering, Thammasat School of Engineering, Thammasat University, THAILAND.

² Faculty of Industrial Technology, Suan Sunandha Rajabhat University, THAILAND

³ Bureau of Highway Safety, Department of Highways, Ministry of Transportation, Royal Thai Government, THAILAND

*Corresponding Author (Email: rwinai @ engr.tu.ac.th).

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Abstract

This research studies the factors affecting the proportion of types of trip generation from six community malls of different sizes and locations in Thailand. An analysis of results from the interview data reveals that the type of trip generation does not depend on the size of community malls, but it depends on the day of the week and its location. Most trips to a community mall near a community or urban area are primary trips. These primary trips tend to be higher on the weekend. Moreover, the proportion of primary trips for community malls located in the nation's capital is higher than those located in the regional urban areas. The data also suggests that a community mall located on a major road will have a significantly higher proportion of pass-by trips than primary and diverted trips. In particular, the community mall sited on the main road away from a community will generate pass-by trips as high as 98 percent of all trips.

Disciplinary: Civil Engineering (Transportation and Traffic Engineering).

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1. Introduction

A community mall is one type of land development that is a convenient and fulfilling center for consumers. It consists of restaurants, food courts, convenience stores, supermarkets, shops, banks, fitness, and much more. In Thailand, the community mall is the second-largest service after retail stores, with a growth rate of 30% per annum (Kongcheep, 2019). It spreads over urban areas, suburban areas, and main provincial routes. As a result of this expansion, a community mall is one of the land developments that generates more trips on the road network. To minimize traffic

problems on the road network around the community mall. Therefore, a traffic impact study is required before the project is developed (Namwong et al., 2021).

Trips generated by a new development consist of three types: primary trips, pass-by trips, and diverted trips. The pass-by trips are already part of the existing traffic pattern (pass-by trips) while others are completely new trips (Institute of Transportation Engineers, 2005). Traffic impact assessments will be precise and close to actual conditions, depending on the accuracy of the forecast of type of trips. The study in the US (Institute of Transportation Engineers, 2014) suggests that type of trips depends on the type of development. The study also recommends ranges of pass-by rates for each development types. Brehmer and Butorac (2003) studied trip generation characteristics of supermarkets in the US. They found that, on average, 52 percent of the trips generated by the supermarket stores were primary trips. Moreover, there were some variations between the pass-by and diverted percentages based on the location of the store. In another study in New Zealand, Steedman et al. (2016) studied the type of trips of five supermarkets in New Zealand. The data suggested that the proportion of primary, pass-by, and diverted trips depended on the location of the supermarket and the distance to the nearest competitors. Additionally, the distance to the nearest major road also affected the proportion of diverted trips.

Based on the literature, there is no study on the trip types of community malls both in Thailand and foreign countries. However, this area of study is important for the traffic impact study, in Thailand, to represent actual traffic conditions. Therefore, this study intends to give a finding and detailed analysis of the type of trips of community malls in Thailand.

This study investigates the proportions and factors that affect three types of trip generation: primary trips, pass-by trips, diverted trips of six community malls in Thailand.

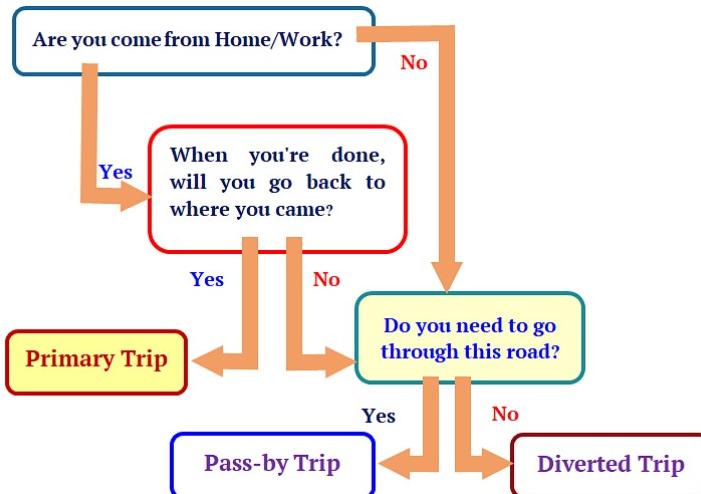


Figure 1: Process flowchart of the questionnaire and result

2. Method

The data was collected and used to analyze three types of trips generated by six community malls in Thailand. The data collection method was done through interviews with community mall customers who came by private cars. The interviews were conducted from at least 400 samples at each location on weekdays and weekends during two time periods, morning and afternoon peak

hours. The questionnaire survey needs to be simple and easy to answer. However, it must be possible to determine what type of trip each person made. The questions used to interview are shown in Figure 1.

3. Analysis and Results

3.1 Community Malls Characteristics and Proportion of Types of Trips Generation

3.1.1 Community Mall Characteristics

Characteristics observed at each community mall are

- Location 1: It is a medium-sized community mall with a gross service floor area of 12,000 square meters and 285 parking spaces. This community mall is sited in the capital city of Thailand, Bangkok, and open to service daily from 10:00-22:00. There are few nearby competitors and alternative routes.
- Location 2: It is a large-sized community mall with a gross service floor area of 24,400 square meters and 565 parking spaces. This community mall is sited in the capital city of Thailand, Bangkok, and open to service daily from 10:00-22:00. There are many competitors in the adjacent area. Its customers use a nearby major road as an alternative route accessed this community mall.
- Location 3: It is a large-sized community mall with a gross service floor area of 19,900 square meters and 187 parking spaces. This community mall is sited in the urban area of a province in the northern part of Thailand and open to service daily from 10:00-22:00. There are many competitors in the adjacent area. Adjacent roads are used as alternative routes accessed to this community mall.
- Location 4: It is a small-sized community mall with a gross service floor area of 5,000 square meters and 187 parking spaces. This community mall is sited in the urban area of a province in the eastern part of Thailand and open to service daily from 10:00-22:00. There are many nearby competitors. Adjacent roads are used as alternative routes entering the premises.
- Location 5: It is a large-sized community mall with a gross service floor area of 16,000 square meters and 420 parking spaces. This community mall is sited on a major road near a community and open to service daily from 10:00-22:00. There are many competitors in the adjacent area. Adjacent roads may be used as alternative routes entering the premises.
- Location 6: It is a small-sized community mall with a gross service floor area of 3,200 square meters and 300 parking spaces. This community mall is sited on a major road away from a community and open to service 24/7. There are many competitors in the adjacent area. There is no alternative route to enter the premises.

Based on the characteristics of six community malls describes above, they could be divided by their locations into 4 groups: in the capital city (Location 1 and 2), in the regional urban areas (Location 3 and 4), on a major road near a community (Location 5), and a major road away from a community (Location 6). The statistical summaries will be discussed in the next section.

3.1.2 The Proportion of Trip Generation

According to the interview data from six community malls during two time periods on weekdays and weekends, primary trips and pass-by trips are dominant. The data also shows that the proportion of trips generated by the community mall customers depends on its location. The results, in Figure 2, can be summarized as follows.

Trips generated by the community malls sited in the urban area (Location 1-4) are primary trips range between 26 and 94 percent as shown in Figure 2. These primary trips tend to be higher on the weekend. The proportion of primary trips for community malls located in the capital city (Location 1 and 2) is higher than those located in the regional urban areas (Location 3 and 4) during two time periods on weekdays and weekends. It is because the density of the community surrounding the community mall areas (at Locations 1 and 2) is much higher than the community mall area (in Locations 3 and 4.) Moreover, Locations 1 and 2 are the center of most activities such as office buildings, hospitals, schools, and so on. Therefore, Locations 1 and 2 generate more primary trips than the other Locations.

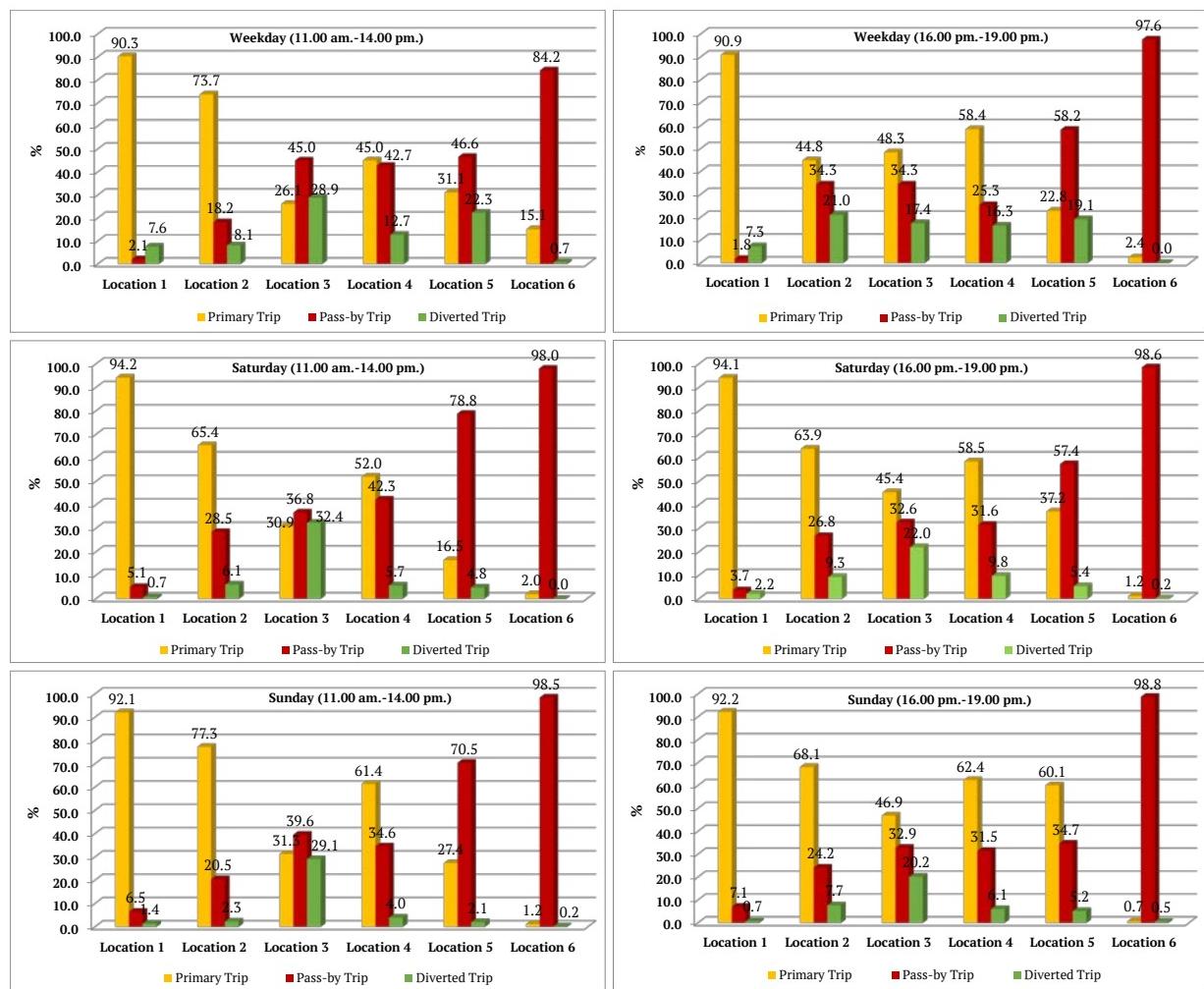


Figure 2: Proportion of Trip Generation during Weekday and Weekend

The data, in Figure 2, also suggests that a community mall located on a major road (Location 5 and 6) will have a significantly higher proportion of pass-by trips than primary and diverted trips, especially during the weekend. In particular, the community mall sited on the main road away from a community will generate pass-by trips as high as 98 percent of all trips.

3.2 Relationship between Proportions and Time Periods

Chi-square at a significance level of 0.05 was used to test the similarities of proportions of trip generation between times of the day. The p-value for chi-square tests comparing the primary,

pass-by, and diverted trips at each location, given in Table 1, indicates the likelihood that the differences were observed between the sets of data.

The stars in Table 1 mean that statistically significant differences were found ($p \leq 0.05$). The statistical summary in Table 1 shows statistically different characteristics of trip proportions for most community malls. Therefore, it is most likely that the proportions of trips (primary, pass-by, and diverted trips) depend on the times of the day. During the weekend, however, a community mall located on a major road away from a community (location 6) has the same proportions of trips between PM. peak hour and peak hour of the generator on both Saturday and Sunday since most of its customers are travelers between major cities.

Table 1: The Statistical Summary of Similarity Test of Proportions Between Times of Day (PM. Peak Hour and Peak Hour of Generator) Using Chi-square

Location	Weekday		Saturday		Sunday	
	X^2	P-value	X^2	P-value	X^2	P-value
Location 1	0.14	0.93	4.01	0.13	1.26	0.53
Location 2	73.00	<0.01*	3.19	0.20	16.68	<0.01*
Location 3	27.72	<0.01*	20.36	<0.01*	22.77	<0.01*
Location 4	29.87	<0.01*	12.67	<0.01*	2.67	0.26
Location 5	11.51	<0.01*	47.42	<0.01*	108.91	<0.01*
Location 6	44.74	<0.01*	1.81	0.4	0.85	0.65

3.3 Relationship between Proportions and Days of the week

Chi-square at a significance level of 0.05 was also used to test the similarities of proportions of trip generation between days of the week. The p-value for chi-square tests comparing the primary, pass-by and diverted trips at each location, given in Table 2, indicates the likelihood that the differences observed between the sets of data.

Table 2: The statistical summary of similarity test of proportions between days of the week

Time 11.00-14.00 hr.	Weekday/ Saturday/ Sunday		Weekday/ Saturday		Saturday/ Sunday		Weekday/ Sunday	
	X^2	P-value	X^2	P-value	X^2	P-value	X^2	P-value
Location 1	45.87	<0.01*	28.86	<0.01*	1.79	0.41	26.77	<0.01*
Location 2	29.21	<0.01*	12.61	<0.01*	17.63	<0.01*	15.10	<0.01*
Location 3	6.93	0.14	5.86	0.05	1.15	0.56	3.39	0.18
Location 4	38.46	<0.01*	13.02	<0.01*	7.66	0.02	33.07	<0.01*
Location 5	158.07	<0.01*	100.14	<0.01*	17.61	<0.01*	91.76	<0.01*
Location 6	90.36	<0.01*	48.26	<0.01*	1.70	0.43	53.53	<0.01*
Time 16.00-19.00 hr.	Weekday/ Saturday/ Sunday		Weekday/ Saturday		Saturday/ Sunday		Weekday/ Sunday	
	X^2	P-value	X^2	P-value	X^2	P-value	X^2	P-value
Location 1	45.38	<0.01*	14.10	<0.01*	8.01	0.02	37.58	<0.01*
Location 2	65.33	<0.01*	38.74	<0.01*	1.85	0.40	52.83	<0.01*
Location 3	2.78	0.60	2.73	0.26	0.42	0.81	1.08	0.60
Location 4	24.73	<0.01*	9.49	<0.01*	4.24	0.12	22.51	<0.01*
Location 5	155.12	<0.01*	45.69	<0.01*	45.72	<0.01*	126.18	<0.01*
Location 6	6.53	0.16	2.84	0.24	0.80	0.67	5.81	0.05

The stars in Table 2 mean that statistically significant differences were found ($p \leq 0.05$). The statistical summary in Table 2 shows that the proportions of trips (primary, pass-by, and diverted trips) on the weekday are significantly different from on the weekend for most community malls.

The possible reasons behind this are that many people tend to spend their free and family time (shopping, eating, exercising) on the weekend where they have some extra time.

3.4 Relationship between Proportions and Gross Service Floor Areas

As discussed in the previous section, trips generated by community malls are mainly primary and pass-by trips. Therefore, the Pearson coefficient correlation was used to determine the strength of the linear relationship between proportions of trip generation and gross service floor areas of community malls. Values that are close to +1 or -1 indicate a strong relationship between the two variables.

The statistical results Table 3 shows that the proportion of pass-by trips was likely to decrease as the size of the community mall decreased. However, the correlation was still relatively low, so it suggested that the size of the gross service floor area did not change the proportion of the pass-by trips. Additionally, the results in Table 3 also shows the positive relationship between the size of the gross service floor area and the proportion of primary trips. This positive relationship means that the proportion of primary trips was likely to increase as the size of the community mall increased. However, the correlation was still relatively low (not close to 1), so it suggested that the size of the gross service floor area did not change the proportion of the pass-by trips.

Table 3: The Statistical Summary of Correlation Test between Proportions and Gross Service Floor Area

Pass by Trip	Size	Primary Trip	Size
Weekday (A.M.)	-0.52	Weekday (A.M.)	0.33
Weekday (P.M.)	-0.34	Weekday (P.M.)	0.18
Saturday (A.M.)	-0.43	Saturday (A.M.)	0.26
Saturday (P.M.)	-0.46	Saturday (P.M.)	0.35
Sunday (A.M.)	-0.46	Sunday (A.M.)	0.33
Sunday (P.M.)	-0.55	Sunday (P.M.)	0.43

4. Conclusion

Based on questionnaires data collected from visitors to six community malls in Thailand, the study of types of trip generation are

1. The proportion of types of trip generation of community malls is mainly pass-by trips. It also depends on its location. The values of pass-by trips are as follows:
 - 20-40% for a community mall sited in urban areas
 - 35-80% for a community mall sited on a major road near a community
 - 80-98% for a community mall sited on a major road away from a community
2. The proportion of types of trip generation of community malls depends on the days of the week. The primary trip trends to be higher on the weekend.
3. The proportion of primary trips of community malls located in the nation's capital is higher than those located in the regional urban areas or on a major road.
4. The proportion of types of trip generation does not depend on the size of a community mall.

5. Availability of Data, and Material

Data can be made available by contacting the corresponding author.

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Benchaya Pimcham is a Master's degree student of the Department of Civil Engineering, Thammasat School of Engineering, Thammasat University, Thailand. She earned a Bachelor of Engineering and Management, Thammasat School of Engineering, Thammasat University. She is interested in Traffic Modeling Analysis and Management.



Dr. Winai Raksuntorn received his PhD (Civil Engineering) from the University of Colorado, USA. He is an Assistant Professor in the Department of Civil Engineering, Faculty of Engineering, Thammasat University. His research interests include Transportation Safety Analysis, Traffic Operations, and Management, Traffic Impact Studies, Traffic Flow Modeling, Highway Capacity Analysis, Advanced Traffic Management for Intelligent Transportation Systems.



Dr. Boonsap Witchayangkoon is an Associate Professor in the Department of Civil Engineering, Thammasat School of Engineering, Thammasat University. He received his B.Eng. from the King Mongkut's University of Technology Thonburi with Honors. He continued his PhD study at the University of Maine, USA, where he obtained his PhD in Spatial Information Science & Engineering. Dr. Witchayangkoon current interests involve Applications of Multidisciplinary and Emerging Technologies to Engineering.



Dr. Nareenart Raksuntorn is an Assistant Professor at the Faculty of Industrial Technology, Suan Sunandha Rajabhat University. She received the B.Eng. degree in Electronics Engineering from King Mongkut's Institute of Technology Ladkrabang, Thailand, the M.S. degree in Electrical Engineering from the University of Colorado, and the Ph.D. degree in Electrical Engineering from the Department of Electrical and Computer Engineering, Mississippi State University. Her research interests include Remote Sensing Image Analysis, Image Processing, and Pattern Recognition.



Dr. Songrit Chayanan is Head of Traffic and Transportation Surveys, Bureau of Highway Safety, Department of Highways, Thailand. He earned his Bachelor of Engineering degree with Honors from Thammasat University, Thailand. He got his PhD from the University of Washington, USA. His research is related to the Analysis of Highways Transportation and Accidents.



An Overview on STEM Education in Pakistan: Situation and Challenges

Ali Usman Hali ¹, Sarfraz Aslam ^{1*}, BaoHui Zhang ^{1*}, Atif Saleem ²

¹ School of Education, Shaanxi Normal University, No. 199, South Chang'an Road, Xi'an, 710062, CHINA.

² College of Education and Human Development, College of Teacher Education, Zhejiang Normal University, Jinhua 321004, CHINA.

*Corresponding Author (Email: [sarfrazmian @ nenu.edu.cn](mailto:sarfrazmian@nenu.edu.cn), [baohui.zhang @ snnu.edu.cn](mailto:baohui.zhang@snnu.edu.cn)).

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Abstract

With the rapid development of the global economy and science and technology, STEM education has become an important strategy and approach for the cultivation of scientific and technological innovation talents and the reform of education and teaching in various countries worldwide. This study provides an overview of previous STEM education research studies carried out in Pakistan to clarify the current condition in STEM education in Pakistan. A qualitative research method was used to conduct this study, and 13 previous studies were selected (2008-2020) as the sample. Results indicate that STEM education practices by private sectors are visible more than the public sector. Moreover, it was found that there is a lack of laboratories, equipment, and other resources needed to teach STEM education. In essence, Pakistan's STEM education system is not adequately prepared and centered. There is an exclusive involvement needed by the government to support the efforts of all stakeholders, including the public and private. This study provides some suggestions for future research. Researchers need to design such a function that allows stakeholders to acquire necessary competencies relevant to STEM disciplines. Pakistan will have to overcome many challenges to achieve its goals before producing the STEM experts it needs effectively.

Disciplinary: Education Science & Technology, Human Development.

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1. Introduction

Science, technology, engineering, and mathematics (STEM) term is an emerging theme in contemporary education [1]. The term has mainly been driven to improve the competency and

competitiveness among schools and the curriculum. The concept has implications in the diversified sectors, such as developing the workforce and enhancing national security. However, the term is specifically used in addressing the education policy and curriculum [2]. With the rapid development of the global economy and science and technology, STEM education has become an important strategy and approach for the cultivation of scientific and technological innovation talents and the reform of education and teaching in various countries worldwide. Notably, the concept of STEM education is still emerging in Pakistan; nonetheless, concerning the other developed countries, the concept has prevailed significantly.

Education has been a concerning issue in Pakistan. As per the findings [3], one of the primary reasons behind the decline and low educational structure is the absence of adequate governmental policies that can empower this inadequate educational infrastructure. Though non-governmental bodies and other international organizations have also raised their concerns regarding the poor educational infrastructure and curriculum being applied from the primary and secondary education nonetheless, the only 46% literacy rate indicates how backward the country from the education standard perspective [4]. Furthermore, it can also be observed that the education sector of Pakistan is demonstrating inequality in the provision of education. The same duality in the provision of STEM education is also being observed in Pakistan.

1.1 STEM Concept and Pakistan Government and Private Companies

Pakistan's Ministry for Planning, Development & Reform conducted a seminar [5] and realized that increasing salaries had been the one issue for the public school teachers that restrict them to showcase their actual potential and science-based competencies. Nonetheless, it has also been realized that despite a significant increase in teachers' salaries, no significant change in public education has been achieved. This suggests that besides increasing teachers' salaries, there is a need to introduce teachers with an innovative and advanced teaching style with contemporary academic knowledge so that a more significant impact on the public school sector can be achieved [6]. As discussed, the government has now realized the importance of STEM education. In this regard, it aims to engage the Higher Education Commission and Universities to contribute prevailing the concept of STEM education in Pakistan in order to bring technology and innovative curriculum[7].

Further, A STEM Career Initiative was introduced by a joint partnership between the Higher Education Commission and the Pakistan Institute of Engineering and Applied Science (PIEAS) to enable young people and children to pursue their careers in science, technology, engineering, mathematics-based education. Besides government bodies and institutes like PIEAS, different private companies like TechTree, STEM Innovative Foundations, STEM Pakistan, and others are also playing contributory roles in elevating STEM education in Pakistan in the public and private sectors. For instance, one of the private company Tech for Pakistan, a movement started by the former Senator Usman Saifullah Khan along with Dr. Maria Rashid, promises young talent to a multiplier effect on the education system. The movement aims to recruit and train top graduates

from young professionals to teach low-income schools that lack quality education [8]. Further, one of the other private company STEM Visions, also aims to educate and re-educate young girls with STEM education [9]. STEM Vision also aims to provide free of cost STEM education to all the underprivileged kids of Pakistan.

An increasing field in developed and emerging countries is the convergence of science, technology, engineering, and mathematics, known as STEM education. [10]. STEM Education has appealed much attention from all over the world in recent years. STEM education is generally globalized: in the United Kingdom, Commonwealth countries like Pakistan follow patterns, while in the United States, European and Asian countries appear to follow growth. [11]. Currently, there is little literature on STEM education in Pakistan. Existing literature has shown some STEM Education practices mainly in private sectors; there were also a few STEM programs in some Pakistani universities, but they had not sustained. This research aims to describe the current status of STEM education in Pakistan.

1.2 Research Questions

RQ1. How were STEM education ideas first introduced in Pakistan?

RQ2. What is the current situation of STEM education in Pakistan?

RQ3. When introducing STEM education in Pakistan, what are the challenges?

This research contributes to enhancing the success of STEM education on the syllabus and conceptions in Pakistan, including the materials that provide to the students in different stages and qualifying for STEM education teachers in Pakistan. So, trying to increase the practical activities in this kind of education. This study highlighted the roles of Pakistani Ministry Education in this field and what does it should do for expanding STEM education and determined the benefits of STEM for education outcomes in Pakistan.

2. Methods

Based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), a qualitative research design was used to collect data (Figure 1) from many different online sources, including literature and non-academic literature. A search using variations and combinations of “STEM education,” “STEAM education,” “Science, technology, engineering, math,” and “Pakistan” as search terms were conducted in the Web of Science, ERIC, ProQuest, SpringerLink, and google scholar database. These keywords were used separately as the searching term included in the subject of the articles. From January 2008 to January 2020, the data were gathered through previous studies conducted in Pakistani STEM education, including dissertations, conference papers, book chapters, and published research articles at different stages.

Only 13 articles were selected for this research as a sample after determining the studies according to the criteria. One study for overview Education, three studies for primary education, five studies for secondary school, and four studies for undergraduate. Previous studies covered the

curriculum, teacher, students' activities, and the role of Pakistani government universities and organizations. This study analyzed and classified the studies that were a sample of this view paper.

Table 1: Summary of searched studies

Type	Number	Duration
Journal papers	18	2015 – 2020
Dissertations	3	2012 – 2017
Conference paper	4	2016 – 2018
Book Chapter	1	2008

For more explanation and details in this manuscript, the researchers arranged the studies, which were the sample of this study. Table 2 illustrated the characteristics of the articles.

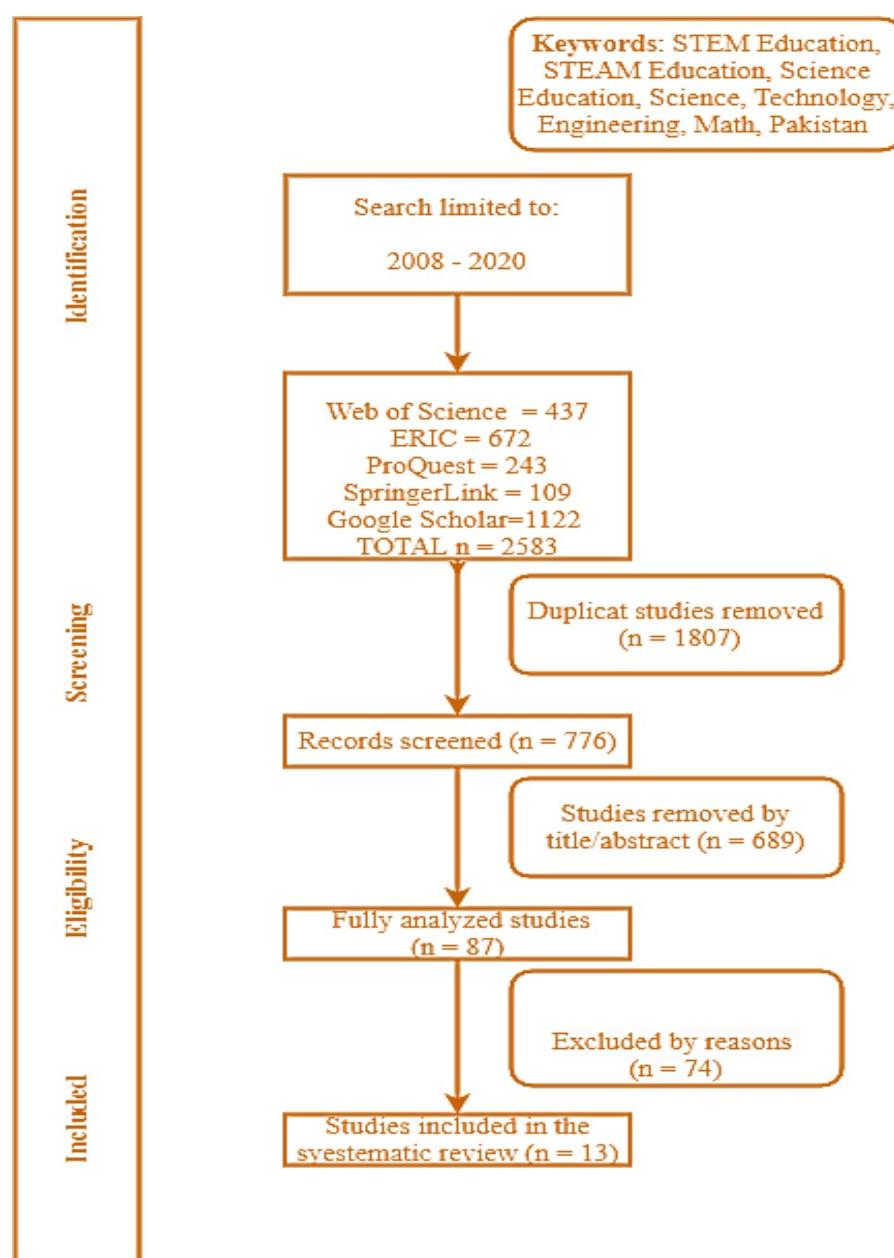


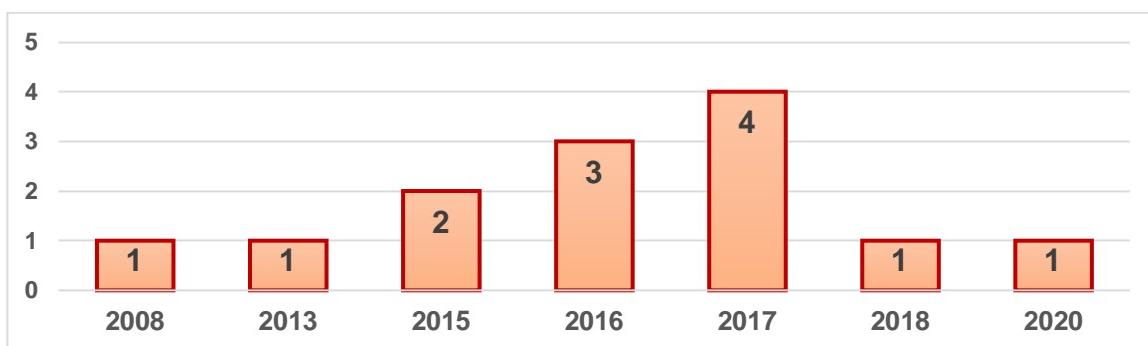
Figure 1: PRISMA Flow Diagram

Table 2: Characteristics of the included studies

Sr#	Article Title	Year	Type	Level	Instruments	Method
1	An Overview Of Science Teacher Education In Pakistan [11]	2020	Article	Overall	overview	Qualitative
2	Teaching Ethics, (Islamic) Values and Technology: Musings on Course Design and Experience [12]	2018	Conference Proceedings	University	Interview and survey	Mix
3	Robotics Education Methodology for K-12 Students for Enhancing Skill Sets Prior to Entering University[13]	2017	Conference Proceedings	K-12	Interview	Qualitative
4	Innovation in Education - Inclusion of 3D-Printing Technology in Modern Education System of Pakistan: Case from Pakistani Educational Institutes [14]	2017	Article	University	Interview	Qualitative
5	Interests and Recruitment in Science: Factors Influencing Recruitment and Retention in STEM Education at University Level in Pakistan [15]	2017	Article	University	Interview and survey	Mix
6	Design-Based Online Teacher Professional Development to Introduce Integration of STEM in Pakistan [16]	2017	Dissertation	6 to 8 grade	Interview and survey	Mix
7	Work in Progress: Shuffled Licht's Model of Learning for Teaching Mathematics Intensive Concepts to Undergraduate Engineering Students [17]	2016	Conference Proceedings	University	Interview	Qualitative
8	Challenges to High School STEM Education in Pakistan[18]	2016	Article	Secondary	Interview	Qualitative
9	STEM5: An Initiative Shaping the STEM Narrative in Pakistan[19]	2016	Conference Proceedings	K-12	Experimental program	Quantitative
10	The Millennium Development Goals Agenda: Constraints of Culture, Economy, and Empowerment in Influencing the Social Mobility of Pakistani Girls on Mathematics and Science Related Higher Education Courses in Universities in Pakistan[2]	2015	Article	University	Interview and survey	Mix
11	Science Education: Issues, Approaches, and Challenges [20]	2015	Article		Interview	Qualitative
12	ICTs in learning: Problems faced by Pakistan [21]	2013	Article	6-12 grade	Interview	Mix
13	Curriculum reform in science education in Pakistan [22]	2008	Chapter	4-12 grade		

3. Results

This study aimed to analyze the previous research studies regarding the STEM system. The analysis was sorted the articles depend on concerning and some studies' recommendations and that studies related to the critical needs and contributing to this field. Figure 2 gives the summarized study outcomes.

**Figure 2:** Year-wise number of studies (2008-2020).

There are several challenges facing STEM education in Pakistan like teaching competencies of STEM teachers, poor syllabus of STEM curriculum; student activities are not enough to achieve

whole goals of this type of education. STEM education practices by private more than public education. Therefore, there is a lack of laboratories, equipment, and other resources needed to teach STEM. The findings [12] have also suggested that this curriculum is more advanced and expensive in comparison with the conventional curriculum. Nonetheless, the outcomes from implementing this curriculum are yet to achieve, because STEM education in Pakistan has not prevailed comprehensively.

Moreover, it also becomes necessary to mention that the unfavorable economic conditions and industrial structure are also some constraints that are not helping this education in the country. However, the researcher has also suggested that soon as the country attains sustainability in its economic condition, there will be higher chances to achieve the desired outcomes and objectives of this curriculum plan [13]. The reason behind this is that with sustainability and development in the industrial sector, more STEM-based jobs can be generated. In developed countries, the concept of STEM education and that is designing the students' curriculum more centered on core subjects like Science, Technology, Engineering, and Mathematics has prevailed more significantly in comparison with developed countries like Pakistan, where the education structure is already declining [14].

The study has revealed that around 66% of schools going children (Figure 3) in Pakistan are enrolled in public schools. However, it becomes essential to mention that the education standard and infrastructure of the public sector is highly unsatisfactory. While accessing the level of STEM education in Pakistan, it becomes vital to consider the level of education and standard of the public school sector. It enrolls a more significant number of school-going students. Nonetheless, it has also been highlighted that the education curriculum and infrastructure in the public sector must be improved significantly. Furthermore, it has also been highlighted that the students going to the public schools in Pakistan have enough potential and skills to effectively compete with the students learning at privilege private schools [15].

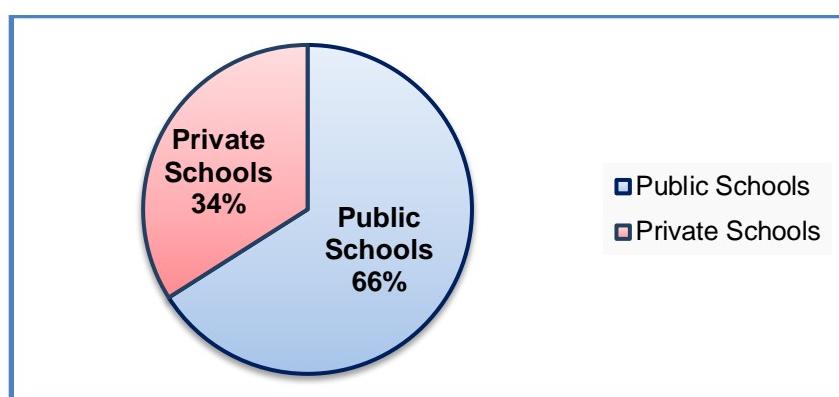


Figure 3: School-Going Children (%).

Improving the standard of STEM education in Pakistan through cross-disciplinary research, teaching, and syllabus collaborations so that future generations of educators and learners can

leverage appropriate STEM expertise and skills for themselves and others in addressing existing and emerging challenges. In essence, the STEM education system in Pakistan is not adequate. Most studies show that the Ministry of Education's efforts and ground-up activities by private and public organizations are exclusively involved and need to be sponsored.

4. Conclusion

STEM Education is the general word for curriculum in science, technology, engineering, and math. It is not, however, a generic term for specific subjects, but an education with realistic, extensive, transparent, and other features. It provides students with a bridge of opportunities to understand the world as a whole so that students can turn the scattered knowledge they have learned into a unified whole that is interconnected. It is an interdisciplinary learning method to eliminate obstacles in traditional teaching that separate knowledge of various subjects and are not conducive to the comprehensive solution of practical problems for students. STEM education in Pakistan is facing many challenges like teaching competencies of STEM teachers, poor syllabus of STEM curriculum, student activities are not enough to achieve the whole goals of this type of education. STEM education practices by private more than public education. Therefore, there is a lack of laboratories, equipment, and other resources needed to teach STEM. Pakistan needs sustainable development in the industrial sector; then, more STEM-based jobs can be generated. In essence, Pakistan's STEM education system is not adequately prepared and oriented, and the government needs exclusive participation to promote the efforts of all stakeholders, both public and private stakeholders.

STEM education plays vital roles in Pakistan's big challenge. For the records, we intended in this study to appear the reality of STEM education in Pakistan for many reasons. First, the Pakistani government has launched that kind of education and needed too many studies around this area for attempting to attain high-quality education and sustainable development. It might lead the Pakistani government to create a positive collaboration with other countries in the world. Second, STEM education should be cover all the learning stages and allocating the particular curriculum appropriating with available equipment and laboratories. Third, STEM education needs more support from the Pakistani Government to catch the fast growth in the world. Fourth, encouraging the researches in this field and provide the researchers with the data and information that pursuit to develop this kind of education in Pakistan.

5. Availability of Data and Material

Data can be made available by contacting the corresponding author.

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Ali Usman Hali is a Doctoral student at the School of Education, Shaanxi Normal University (SNNU), China. He received his Master's degree in Education from Shah Abdul Latif University and Government College University Faisalabad (GCUF), Pakistan. His research interests are Education Technology, Science Education, and STEM Education.



Dr. Sarfraz Aslam is a Postdoctoral Fellow at the School of Education, Shaanxi Normal University, Xi'an (SNNU), China. He received his Doctoral Degree in Comparative Education from Northeast Normal University (NENU), Changchun, China. His research focuses on Teacher Education, STEM Education, and Distance Education.



Professor Dr. BaoHui Zhang is a Professor (Former Dean) at the School of Education, Shaanxi Normal University, Xi'an (SNNU), China. He received his Ph.D. Degree in Educational Technology from the University of Michigan, USA. His research focuses on Education Technology, K-12 STEM Education, and Science Education.



Dr. Atif Saleem is a Postdoctoral fellow at the College of Education and Human Development, College of Teacher Education, Zhejiang Normal University (ZJNU), China. He received his Doctoral degree in Comparative Education from Northeast Normal University (NENU), China. His research interests include Educational Leadership and Management, Higher Education, K12 Education, Teacher Education, and Comparative Education.



The Position of Risk Propensity and Resilience among Saudi Youth Vis-à-vis Certain Other Nationalities

M M Sulphey^{1*}

¹ College of Business Administration, Prince Sattam Bin Abdulaziz University, SAUDI ARABIA.

*Corresponding Author (Tel: +966-546013902 Email: s.manakkattil @ psau.edu.sa).

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Abstract

Risk propensity and resilience are two constructs that are essential for youth in any society. The two significantly impact individuals' personalities and decision-making capacity under situations of risk and uncertainty. While risk propensity is a dispositional tendency that defines future accomplishments, resilience is an essential characteristic that helps individuals "bounce back" from problems associated with past risks and failures. Youth having the two attributes of high-risk propensity and resilience will make better personal, societal, and organizational decisions and lead their respective organizations and countries towards growth and success. The study intends to assess Saudi youth's risk propensity level and compare it against a sample from a developing and developed country. It is also intended to determine the relationship that risk propensity has with resilience. Appropriate data collection tools and statistical, this study findings are significant to societal, academic, and practical uses. Being a topic with little empirical attention in the Kingdom, the study results are expected to trigger further interests in the area.

Disciplinary: Management Science, Youth Studies, Psychology.

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1. Introduction

Risk propensity (RP), based on the Prospect Theory proposed by Kahneman & Tversky (1979), is the willingness to face risks, which makes significant impacts on the decision-making capacity of individuals under conditions of risk and uncertainty (Keil et al., 2000). It is conceptualized as "a confluence of dispositional tendencies" derived from specific cognitive inputs

as well as the varying experiences of the individual. It is a quality that defines future accomplishments and is indispensable for youth across nationalities (Nicholson et al., 2005). Individuals, especially youth, who become inconsistent towards risk by any means, can lack a strategy for a propensity towards or against risks. This could bring disastrous effects to the individual and society.

Resilience, defined as the "ability to recover and return once again to those former behaviors of adaptation that characterized the individual before the period of disruption" (Walter, 2000), is multi-disciplinary. Resilience is a self-psychological mechanism that can shield individuals from hard/difficult times' consequences (Sulphey, 2020). It aids individuals in recuperating from stressful life events and encountering stressful and traumatic incidents. Resilient individuals display a strong and dynamic psychological trait of adapting to and coping with adversities (Masten, 2001).

Many cultural, trans-situational, individual, and personality factors are found to influence RP and Resilience. Youth having the two characteristics of high-risk propensity and resilience will be capable of making better personal, societal, and organizational decisions and lead their respective organization and country towards growth and success. Multiple empirical studies have been undertaken to understand the socio-economic and cultural relationship between these constructs and other psychological and organizational behavior concepts (Nicholson et al., 2005; Sulphey, 2020; Wang et al., 2015), giving impressive results. In light of the current pandemic (Covid-19), society and organizations require members who are bestowed with the trait of resilience. This will help in recovering effectively from the consequences of challenging and difficult times. This study identifies the position of Saudi Arabian youth, vis-à-vis a few other nationalities, to find out the level of RP and resilience among Saudi youth. It also compares the study results with that of certain other nationalities – developed and developing. The study also examines if RP has any impact on resilience.

RP and resilience have been a matter of massive conceptual and empirical examination in almost all parts of the world (Keil et al., 2000; Luthar et al., 2000; Nicholson et al., 2005; Wang et al., 2015). However, despite its indispensability as a personality characteristic, a fair review of the literature revealed that it had received scant attention in the Asian context in general and Saudi Arabia. This study is of immense academic and social significance as it intends to fill this literature gap.

2. Review of Literature

2.1 Theoretical Background

The theoretical underpinnings about risk propensity are based on different theories. The prominent among them is the Prospect Theory (Kahneman & Tversky, 1979), which has triggered multiple research studies. The theory states that risk-taking behavior is uneven in any reference point. Individuals tend to be risk-averse on occasions when having a perception of gain. However,

they turn risk-seeking when they perceive a loss (Sulphey, 2014). Another critical premise about the Prospect theory is that there is relative inconsistency concerning individual risk-taking. This is based on the particular situation. An individual who takes the risk in one situation may avoid it in another circumstance. However, contra views have also been found expressed by certain others. For instance, risk preferences were found to persist across circumstances by Weber and Milliman (1997). Empirical evidence exists to show that risk-taking could also be associated with certain other factors like personality, domains (Zuckerman & Kuhlman, 2000), and heritability (Farde et al., 1997). Sitkin and Pablo (1992) believe that risk propensity occurs due to "dispositional tendencies, cognitive inputs, and past experiences."

Resilience theory is an applied field of study of day-to-day use and can benefit humans and society (Luthar et al., 2000). Resilience Theories identify factors that build resilience (Greene et al., 2004). This could include enhancing individuals' competence to facilitate overcoming the adversities and boosting their capacity to survive.

2.2 Risk Propensity (RP)

RP has received a broad examination in business research (Bernstein, 1996) and psychology – in particular, personality (McCrae & Costa, 1997). It is identified as the cumulative inclination of individuals to either face or be averse to risk (Sitkin and Weingart, 1995). Both of them exist simultaneously and are found to evolve. In simple parlance, RP is "an individual's current tendency to take or avoid risk" (Pablo, 1997). Based on two aspects, RP involves the individual's risk-taking behavior(s) of the individual and the multiple environmental and situational factors. While some consider RP as a trait stable and constant over a period, certain others argue that it changes with the learning process (Gerrans et al., 2012; Hung et al., 2010). As an individual advances across a period and gains experiences, RP tends to achieve persistence (Hung et al., 2010). This is a pointer towards the fact that there could be vast differences in RP based on experience.

RP involves the locus of control (Sulphey, 2016) and is used in multiple contexts (Hung and Tangpong, 2010; Weber et al., 2002), including the present dynamic and unpredictable business milieu (Hung and Tangpong, 2010), investments and economics (Kapteyn and Teppa, 2002), marketing (Weber et al., 2002), and general business (Hung and Tangpong, 2010). RP is also profoundly influencing business decisions, individual behaviors, and various other outcomes (Bernstein, 1996). Empirical exists to prove the ability to "absorb and recover from shocks" in the risks' backdrop linking with stressors change pangs and uncertainties, based on the resilience's quality. RP is also associated with employee performance and intention to quit (Allen et al., 2007), firm performance (Saini and Martin, 2009) as well as strategic risk-taking (Devers et al., 2008).

Social scientists opine the general shift of attention from risk mitigation to increase in resilience. This is of absolute necessity to successfully navigate the highly turbulent business scenario (Hamel and Valikangas, 2003). Thus, individuals need to assume the risk and develop resilience (Luthans and Youssef, 2004). This has been confirmed by Gerben et al. (2015), who opined that taking risks head-on would enhance resilience and facilitate quick recovery.

2.3 Resilience

Positive psychologists take resilience as something that is 'right and good about people,' and can be conserved as dispositional and trait-like. Two characteristics influence an individual's capacity for resilience – external or contextual and internal or psychological. Having high resilience levels, individuals can invoke an array of positive emotions to recover from their adverse experiences (Luthar et al., 2000), as they are emotionally stable even faced with adversity. Resiliency can restore confidence, hope, and optimism after a challenging experience. It is also an antecedent to a host of specific other positive outcomes. Luthans (2002, p. 702) defined resilience as

"the developable capacity to rebound or bounce back from adversity, conflict, failure or even positive events, progress, and increased responsibility."

Resilient people are observed to repeatedly restore their self-efficacy after a setback (Youssef and Luthans, 2005). Resilient workers have been found to perform better (Hind et al., 1996; Luthans et al., 2005), have a better adaptive capacity, and are successful (Luthans et al., 2005). Resilient employees use their negative experiences in such a way to increase their performances subsequently. They are better adaptable during uncertainty and create better and higher value for their organizations (Hind et al., 1996). Further, the construct is positively associated with multiple constructs, including extraversion, agreeableness, conscientiousness, long-term orientation, and so on (Campbell-Sills et al., 2006; Sulphey, 2020; Yu and Zhang, 2007). Resilience has been found to enhance mental health, subjective wellbeing, and improved overall performance (Robertson et al., 2015). It needs to be noted that the majority of the studies about risk propensity and resilience have been conducted elsewhere, particularly in the western world. No research seems to have been undertaken about these aspects of Saudi Arabia. This work is an earnest work towards filling this gap in the literature.

3. Methodology

Two standardized and validated measuring instruments were applied to the collected data. Both of them have been widely used in many empirical studies (Saini and Martin, 2009; Smith, 2019; Sulphey, 2020). To collect data, the particulars of the questionnaires are

- (1) **RP:** This variable was measured by the General Risk Propensity scale, developed, standardized, and validated by Hung et al. (2012). The questionnaire, which consisted of eight items, had a Cronbach's alpha of 0.76. This alpha was obtained during a cross-cultural study. The questionnaire thus enjoys good internal consistency.
- (2) **Resilience:** Resilience was measured using the refined Connor–Davidson resilience scale (Campbell-Sills and Stein, 2007). This questionnaire has also reported good internal consistency and fit indices. Cronbach's alpha was 0.85. The scale with had ten items had two factors, which were hardiness and persistence.

Both the questionnaires had a five-point scale, which ranged from strongly agree to disagree strongly. The demographics of the respondents like gender, age, course of study, etc. were also

elicited. Since the data was to be collected across various nationalities, Google Docs was used. The link containing the questionnaire was posted to educators and professors who were members of certain specialized educators' social networking groups (SNG),. Help was solicited from these educators for collecting responses from their students. Educators from Management/ Business Administration departments were only involved in the study. Several professors across continents responded to the request and offered to help in the data collection during January-April 2020. They directed their respective students to respond to the link containing the questionnaire. Close co-ordination was kept with such professors and educators who responded so that the required follow-up actions could be done. Data could be collected randomly for over three months from a total of 309 samples, who were management/ business administration students. Since all the items were made compulsory in the questionnaire, none of the responses warranted rejection. All the responses were complete by themselves and could be meaningfully used for analysis. The Kaiser-Meyer-Olkin (KMO) value 0.788, and Bartlett's test of sphericity 1062.773, indicate significant (<0.001), thereby confirming sampling adequacy (Kaiser and Rice, 1974). Table 1 presents the breakup of the sample.

Table 1: Nation wise breakup of sample

No	Country	Number	Percent
1	Saudi Arabia	58	18.77
2	United States of America	60	19.41
3	France	52	16.83
4	India	49	15.86
5	Bangladesh	60	19.42
6	Palestine	30	9.71
	Total	309	100.00

There were 196 males (63.4%) and 113 (36.6%) females. The respondents' minimum age was 19 years, with a mean of 22.42 and SD 3.65. Table 2 provides the overall descriptive statistics of the sample.

Table 2: Descriptive statistics

Particulars	Risk propensity	Resilience
Mean	29.676	30.091
Median	30.000	31.000
SD	4.93	4.55
Minimum	10.00	11.00
Maximum	40.00	40.00

The measurement model's reliability and validity were confirmed with Exploratory and Confirmatory Factor analyses (EFA and CFA). This was done for all the variables, and items in the proposed research model were examined (Byrne, 2013).

Since the EFA presented a few weak and cross-loadings for five items, they were dropped. These weak and cross-loadings were observed in two items in resilience (RS11 and RS12). These items were dropped before conducting CFA. During the CFA, it was observed that there was low factor loading for one item, with a p-value less than 0.05. As such, this item (RP9) was also dropped.

Table 3: Particulars regarding validation

Variable	Individual items	Loadings of CFA	Average Variance Extracted	Composite Reliability	Alpha values
RP	RP1	0.59	0.70	0.84	0.85
	RP2	0.50			
	RP3	0.56			
	RP4	0.56			
	RP5	0.54			
	RP6	0.53			
	RP7	0.52			
	RP8	0.58			
Resilience	RS1	0.50	0.71	0.77	0.78
	RS2	0.52			
	RS3	0.52			
	RS4	0.54			
	RS5	0.59			
	RS6	0.59			
	RS7	0.52			
	RS8	0.53			
	RS9	0.59			
	RS10	0.53			

Table 3 presented the validation of the questionnaires, that all the standardized factor loadings are above the stipulated 0.50 (Kline, 2016). The average variance extracted (AVEs) has met the thump rule of 0.70 (Hair et al., 2010), thereby confirming the constructs' internal consistency. The Composite reliability (CR) of both the constructs is above 0.60, as stipulated by Bagozzi et al. (1991). The Alpha values of both the constructs are above stipulated 0.70, endorsing the reliability (Nunnally et al., 1978). According to Hair et al. (2010), the measurement model's relative strength could be judged by the convergent and discriminant validities. Convergent validity is the extent to which the individual items in the latent factors positively correlate with the factor. The CFA output shows that the variables fit significantly with the model ($p < 0.001$) to their assumed factors.

Discriminant validity indicates that the constructs share more variance with the measures than the other constructs (Hulland, 1999). The correlation between the two constructs was .210. This is within Anderson and Gerbing's (1988) stipulation that the r of the constructs needs to be less than 0.70 for having discriminant validity. Further, the r -value was also lesser than the square roots of AVE. This is as per the stipulation of Fornell and Larcker (1981). These point towards the reliability and validity of the constructs used for this study. Having confirmed the constructs' reliabilities and validities, the data analysis can be executed.

4. Results

Correlation and regression analyses were done for this study. The correlation was done to identify the relationship between propensity to take risks and resilience. It was found that the r -value was .260, which was significant at the 0.01 level. This denotes that the two constructs have a significant relationship. Regression analysis was after that done, and Table 4 presents the results. It can be found that the independent variables risk-taking explains 6% of the variation in resilience.

F value was found to be 22.202, which was significant. This shows that the model of regression is adequate. Thus, it is clear that the variable of risk-taking explains resilience.

Table 4: Results of regression

Model	Unstandardized Coefficients		Beta	t	Sig.
	B	Std. Error			
1	(Constant)	21.707	1.234	17.592	<0.001
	Resilience	.193	.041		
$R^2 = .067$		$F = 22.202$		$Sig = 0.00$	

4.1 Inter-Country Analyses

This study also determines any difference in the variables studied for various nationalities using data collected from six countries. ANOVA was conducted to determine if there existed any difference in the variables based on the samples' nationalities. Table 5 presents the results. It can be found that significant differences existed (sign. <.001) for both the variables – propensity to take risk and resilience. This denotes a significant difference in the risk-taking attitude and resilience based on the respondents' nationalities.

Table 5: Results of ANOVA

Variable		Sum of Squares	Df	Mean Square	F	Sig.
The propensity to take risk	Between Groups	2156.693	5	431.339	24.562	<.001
	Within Groups	5320.945	303	17.561		
	Total	7477.638	308			
Resilience	Between Groups	498.253	5	99.651	5.134	<.001
	Within Groups	5881.209	303	19.410		
	Total	6379.463	308			

Note: The F values are significant at .000

Table 6: Country-wise results of t-test

Country		Mean	SD	t-value
Saudi Arabia	Risk propensity	24.86	2.92	Xx
	Resilience	24.97	5.42	Xx
USA	Risk propensity	27.15	2.76	4.377**
	Resilience	32.48	3.29	9.147**
France	Risk propensity	26.79	2.93	3.449**
	Resilience	30.52	3.10	6.495**
Palestine	Risk propensity	27.63	4.75	3.388**
	Resilience	27.50	3.62	2.306**
India	Risk propensity	28.43	3.71	5.566**
	Resilience	29.94	4.67	5.037**
Bangladesh	Risk propensity	29.90	3.27	8.819**
	Resilience	31.57	4.31	7.338**

Note: ** significant at 0.01 level

To find out how Saudi Arabian respondents differ from other nationalities, a t-test was done, and Table 6 presents the results. The analysis has been done for samples from Saudi Arabia and other countries under study. It was found that all the t-values were significant at the 0.01 level. This denotes a significant difference between the Saudi sample for RP and resilience and that of the other countries studied. The mean value of all the RP scores is found to be higher than that of the Saudi Arabian sample. The mean value of less developed countries and those with higher levels of uncertainties were found to have higher levels of RP than respondents who are residents in developed countries. This shows that citizens of countries with higher levels of uncertainties or

risk had higher levels of RP. This could be due to the socio-economic status prevalent in the economies. The level of risk in such economies is higher, and if the citizens are to survive, they need to have a better propensity towards risk.

5. Discussion

Risk propensity has multiple vital implications for the understanding of risk behavior. These implications could have theoretical and practical efficacy. Risk propensity provides deep insights into the motives behind individual selection and engagement in risky behaviors. In organizational terms, a better understanding of risk behavior could contribute significantly to risk management programs.

The studied result has immense potential in terms of academic, theoretical, and practical usage. In the present uncertain and competitive world, for Saudi Arabia to surge ahead and achieve the objectives identified by Vision 2030, the Saudi Arabia Kingdom would require a band of educated youth who have a sufficiently high level of RP and resilience.

Many social scientists have found risk-taking to be an essential property for entrepreneurship (Block et al., 2015; Hisrich and Peters, 2002; Sulphey, 2020) since new ventures could face ample possibilities of failure (Antoncic et al., 2015). Thus, risk propensity is considered an essential feature in entrepreneurship (Brockhaus, 1980; Sulphey and Salim, 2020). Substantial evidence shows that culture is a critical determinant in risk-associated behaviors (Eroglu and Picak, 2011; Herbig, 1994; Hofstede, 1980). Certain cultures accord high value for behaviors that encourage sweeping innovation, while others emphasize conformity, group welfare, and scant risk-taking and behavior (Hayton et al., 2002; Herbig, 1994; Hofstede, 1980).

6. Conclusion

This study assesses the level of Risk Propensity of Saudi youth and compares it against a sample from developing and developed countries. This study also determines the relationship that Risk Propensity has with resilience. Data was collected from youth from six countries, including Saudi Arabia, using standardized questionnaires. The study was conducted as the constructs of RP and Resilience are constructs that are essential to have a vibrant society and an economy. These behavioral concepts are those who are capable of contributing substantially to the future wellbeing of the Kingdom. RP is a construct that would help individuals tide over the turbulence and uncertainty that is omnipresent in the current societal scenario, particularly in the new normal.

This study provides directions for administrators for making required structural and other changes towards enhancement of risk propensity and resilience and makes the society stronger to face the uncertain world in all dimensions. This study is the first empirical examination in this direction done in Saudi Arabia. As such, the proposed study's findings are expected to trigger further studies in this hitherto unexplored area.

7. Availability of Data and Material

Information can be made available by contacting the corresponding author.

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Professor Dr. M M Sulphey teaches at the Department of Business Administration, College of Business Administration, Prince Sattam Bin Abdulaziz University, AlKharj, Saudi Arabia. He has authored over 100 research articles and eight books. Dr.Sulphey is also Editor and Reviewer of many reputed international journals. His research interests are in the areas of Organizational Behaviour/ Human Resource Management, Sustainability.



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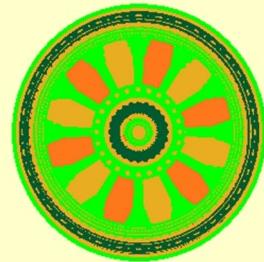
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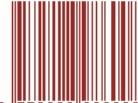
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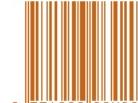
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